

Performance of Boiler efficiency in Thermal Power Plant

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Abstract

The world over energy resources are getting scarcer and increasingly exorbitant with time. In India bridging the ever-widening gap between energy demand and supply by increasing supply is an expensive option. The share of energy costs in total production costs can, therefore improve profit levels in all the industries. Thermal Power Plant is a major source of electricity production by coal. We will understand the overview of Thermal Power Plant i.e its parts such as boiler, turbine etc. Overview of Thermal Power Plant is very important for its better functioning and for its maintenance. The satisfactory design consist of selection of sites; estimation of cost; selection of Boiler, Turbine, Electrical Generator, Cooling System. The Transportation of electrical energy is more economical to the transportation of coal. So, we have to put greater efforts on thermal power plant as it is very economical for us. This reduction can be achieved by improving the efficiency of industrial operations and equipments. Energy plays an important role in identifying energy conservation opportunities in the industrial sector, while they do not provide the final answer to the problem; they do help to identify potential for energy conservation and induces the companies to concentrate their efforts in this area in a focused manner.

Keywords: Thermal Power Plant, Boiler, Boiler efficiency, Direct Method, Indirect Method, Babcock and Wilcox boiler.

INTRODUCTION

A power plant is defined as a machine or assembly of Equipment that generates and delivers a flow of Electrical or mechanical energy. Generally steam power Plant, diesel power plant, gas turbine power plant, Nuclear power plant are called thermal power plant. It is Called thermal power plant because these convert heat Into electrical energy. In the thermal power plant coal to Electricity process occur, it is converting into different Stages. First chemical energy converted into heat energy By burning coal, then heat energy convert into Mechanical energy due to boil of water, then finally Mechanical energy convert into electrical energy by the Working process on turbine section. Power plant is working on the principle of Rankine Cycle.

Boiler

“Boiler is device which is use for power generating by The heating process of water to convert the superheated Steam”. In other way “boiler device is defines as a Closed vessel system whereby the fuel combustion Process, high pressure steam is produced from water”. Basically a steam generator is known as boiler, made by High quality steel. Boiler in thermal power plant accumulated the steam and build up a pressure to the expend it in the turbine and convert thermal energy to mechanical energy. The generator which is connected to turbine convert the mechanical energy into electric energy.

Boiler Efficiency

Saving energy may be one of most interested themes And then one of the most important subjects for boiler. According to bureau of energy efficiency “thermal Efficiency of boiler is defined as the percentage of heat Input that is effectively utilized to generate steam.” It is Also defined as “Boiler efficiency is a ratio between the

Thermal energy is the major source of power generation in India. More than 60% of electric power is produced by steam plants in India. India has large deposit of coal (about 170 billion tonnes), 5th largest in world. Indian coals are classified as A-G grade coals. About 70% of energy generation capacity is from fossil fuels in India. Coal consumption is 40% of India's total energy consumption which followed by crude oil and natural gas at 24% and 6% respectively. India is dependent on fossil fuel import to fulfill its energy demands. The energy imports are expected to exceed 53% of the India's total energy consumption. In 2009-10, 159.26 million tones of the crude oil is imported which amounts to 80% of its domestic crude oil consumption. The demand of electricity has been hindered by domestic coal shortages. Cause of this, India's coal imports is increased by 18% for electricity generation in 2010. India has one of the world's fastest growing energy markets due to rapid economic expansion. It is expected to be the second largest contributor to the increase in global energy demand by 2035. Energy demand of India is increasing and limited domestic fossil fuel reserves. The country has ambitious plans to expand its renewable

energy resources and plans to install the nuclear power industries. India increases the contribution of nuclear power to overall electricity generation capacity from 4.2% to 9%. Now, India became third highest in the world who is generating the electricity by nuclear and plans to construct 18 additional nuclear reactors by 2025, then India will become second highest in the world.

MATERIALS:

The pressure vessel of a boiler is usually made of steel (or alloy steel), or wrought Iron. Stainless steel, especially of the austenitic types, is not used in wetted parts of boilers due To corrosion and stress corrosion cracking. However, ferritic stainless steel is often used In superheater sections that will not be exposed to boiling water, and electrically-heated stainless Steel shell boilers are allowed under the European “Pressure Equipment Directive” for production Of steam for sterilizers and disinfectors. In live steam models, copper or brass is often used because it is more easily fabricated in Smaller size boilers. Historically, copper was often used for fireboxes (particularly for steam Locomotives), because of its better formability and higher thermal conductivity; however, in more recent times, the high price of copper often makes this an uneconomic choice and cheaper Substitutes (such as steel) are used instead.

Boiler Efficiency

Boiler efficiency is a combined result of efficiencies of different components of a boiler. A boiler has many sub systems whose efficiency affects the overall boiler efficiency. Couple of efficiencies which finally decide the boiler efficiency are-

1. Combustion efficiency
2. Thermal efficiency

Apart from these efficiencies, there are some other losses which also play a role while deciding the boiler efficiency and hence need to be considered while calculating the boiler efficiency.

1. Combustion Efficiency

The combustion efficiency of a boiler is the indication of burner’s ability to burn fuel. The two parameters which determine the burner efficiency are unburnt fuel quantities in exhaust and excess oxygen levels in the exhaust. As the amount of excess air is increased, the quantity of unburnt fuel in the exhaust decreases. This results in lowering the unburnt fuel losses but elevating the enthalpy losses. Hence, it is quite important to maintain a balance between enthalpy losses and un burnt losses. Combustion efficiency also varies with the fuel being burnt. Combustion efficiency is higher for liquid and gaseous fuels than for solid fuels.

2. Thermal Efficiency

The thermal efficiency of a boiler specifies the effectiveness of the heat exchanger of the boiler which actually transfers the heat energy from fireside to water side. Thermal efficiency is badly affected by scale formation/soot formation on the boiler tubes.

Basically Boiler efficiency can be tested by the following methods:

- A. Direct Method or Input Output Method.
- B. Indirect Method or Heat Loss Method.

A. Direct Method or Input Output Method: Direct method compares the energy gain of the working fluid (water and steam) to the energy content of the fuel. This is also known as input-output method due to the fact that it needs only the useful output (steam) and the heat input (i.e. fuel) for evaluating the efficiency.

$$\text{boiler efficiency, } \eta = \frac{\text{heat output}}{\text{heat input}} \times 100\%$$

Where,

η = boiler efficiency in % . SFR= steam flow rate in kg/hr. SE= steam enthalpy in kCal/kg.

FEW= feed water enthalpy in kCal/kg. FFR= fuel firing rate in kg/hr.

GVC= gross calorific value of coal in kCal/kg.

B. Indirect Method or Heat Loss Method:

In the heat loss method the efficiency is the difference between the losses and the energy input. In indirect method the efficiency can be measured easily by measuring all the losses occurring in the boilers using the principles to be described. The weaknesses of the direct method can be overwhelmed by this method, which calculates the various heat losses associated with boiler. The efficiency can be arrived at, by subtracting the heat loss percentages from 100. An important advantage of this method is that the errors in measurement do not make significant change in efficiency. The indirect method does not account for Standby losses, Blow down loss, energy loss in Soot blowing, and energy loss running the auxiliary equipment such as burners, fans, and pumps.

Valid losses incorporate with to coal fired boiler:

1. Heat loss due to dry flue gas as sensible heat (L1).

2. Heat loss due to moisture in the coal (L2).
3. Heat loss due to moisture from burning of hydrogen in coal (L3).
4. Heat loss due to moisture in air (L4).
5. Heat loss due to formation of carbon Monoxide- partial combustion (L5).
6. Unburnt losses in fly ash as carbon (L6).
7. Unburnt losses in bottom ash as carbon (L7).

$$\text{Total loss in \%} = \sum_{i=1}^8 L_i$$

8. Loss due to surface radiation and convection (L8).

Boiler efficiency by indirect method:

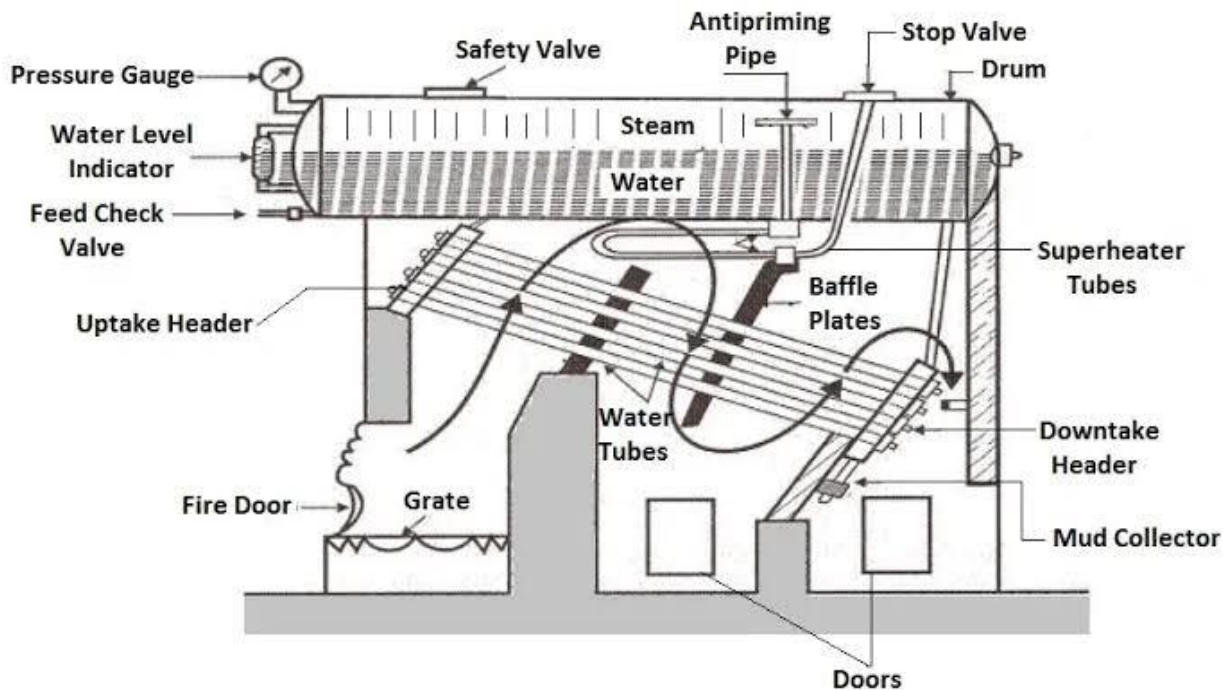
$$\text{Boiler efficiency, } \eta = 100 - (\text{Total loss in \%})$$

Maintenance of boilers:

Effective maintenance can also highlight potential problems quickly and enable corrective action to be taken before there is a major impact on performance. This will improve performance of boilers. Perform regular servicing, analyze flue gas, soot removal, minimize limescale build-up, produce a maintenance plan, manual and logbook, boiler replacement, these are some ways for the good maintenance of boiler. All financial and engineering factors should be considered. Since boiler plants traditionally have a useful life of well over 25 years, replacement must be carefully studied. This paper is convergent on the diverse aspects of the operation of Boiler efficiently. Efficient operation of boiler is likely to play a very big role in following years to come. Industries all over the world are going through increased and powerful competition and increased automation of plants. The suspension cost of such system is expected to be very high. To get away with this challenge, it is clearer by this paper. We have to use the advanced technology and management skills in all spheres of activities to perform its effective role in the turnover of the company.

Babcock & Wilcox Boiler:

Babcock and Wilcox Boiler is a horizontal type drum axis, stationary, high pressure, natural circulation, solid fuel-fired water tube boiler in which coal is burned to heat the water for changing the phase into steam and later that steam is used for power generation. Babcock and Wilcox boiler consists a drum which contains water and stem. The drum is connected to the headers by short tubes. The header at the right hand end of the drum is called downtake header and the other at left handed is called uptake header. A series of inclined tubes are connected to these headers. A hand hole is provided in the header in front of each tube for cleaning the tubes. A mud box is provided just below the downtake header to collect the sediments and rare are removed fr time to time through blow off pipe. Furnace is located below the uptake header. Baffles are provided to deflect the hot gases so as to flow along a longer paths.



Babcock and Wilcox Boiler

Working:

Water from the drum enters the bottom header and flows through the tubes. The hot gases flowing through over the tubes heat and evaporate the water flowing through the tubes. Due to low density, the mixture of water and steam enter the drum through the uptake header. Steam is separated out in the drum and collected water level. The steam from the drum is lead into a superheater which is placed in the path of hot gases. Since the superheater is exposed to the hot gases the steam passing in it will be superheated. Superheated steam is supplied to the prime movers through steam stop valve.

Babcock and Willcox Boiler Parts or Construction consists of:

- Drum
- Water Tubes
- Uptake and Downtake header
- Grate
- Furnace
- Baffles
- Superheater
- Inspection Door
- Water Level Indicator
- Pressure Gauge

Drum:

This is a horizontal axis drum which contains water and steam.

Water tubes: Water tubes are placed between the drum and furnace in an inclined position (at an angle of 10 to 15 degrees) to promote water circulation.

Uptake and Downtake Header:

This is present at the front end of the boiler and connected to the front end of the drum. It transports the steam from the water tubes to the drum. and

This is present at the rear end of the boiler and connects the water tubes to the rear end of the drum. It receives water from the drum.

Grate:

Coal is fed to the grate through the fire door.

Furnace:

The furnace is kept below the uptake-header.

Baffles:

The fire-brick baffles, two in number, are provided to deflect the hot flue gases.

Superheater:

It increases the temperature of saturated steam to the required temperature before discharging it from the steam stop valve.

Inspection Door:

Inspection doors are provided for cleaning and inspection of the boiler.

Water Level Indicator:

The water level indicator shows the level of water within the drum.

Pressure Gauge:

The pressure gauge is used to check the pressure of steam within the boiler drum.

CONCLUSION

From the overall literature review it get concluded that there are so many ways to reduce the energy consumption, energy cost reduction etc. Hence there is a need to prefer energy of every plant once in an year. Different methods used for the analysis and Improvement of boiler efficiency applied by different Researchers. Assessment of performance parameters plays anImportant role in economics of power geResearchers. In Babcock and Wilcox boiler, I concluded that it is more effectively than fire tube boilers.Its pressure limited upto 100bar compare to fire tube boilers. The efficiency is more than fire tube boilers. In so many ways this boiler is used in to produce a large amount of production of steam.

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