O&M Practices and Efficiency Improvements of AFBC Boiler

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Abstract

Energy crisis is one of the vital issues for the developing countries. The population growth and rapid industrialization increases the requirement of the energy sources increases. As per the current scenario, more than 399 thermal power plant are established with 2,34,000 MW generation capacity. The current study represents the energy escaping from the boiler and performance improvement of the AFBC Boiler. The boiler efficiency can be improved by increasing the number of tubes in the economizer, changing the insulation, by changing the fire nozzle angle etc. which enhances the thermal performance of the boiler. The current study focusses on the efficiency improvement of the AFBC boiler by increasing the number of tubes in the economizer. The result shows the thermal performance improvement of the AFBC boiler.

Keywords: Tools to improve boiler efficiency; Efficiency Improvement; Modification in Boiler; AFBC Boiler

Nomenclature

ISO	International Organisation for Standards
RCA	Root Cause Analysis
KPI	Key Performance Indicator
QC	Quality Control
O&M	Operation & Maintenance
OHSMS	Occupational Health Safety Management System
AFBC	Atmospheric Fluidised Bed Combustion
VFD	Variable Frequency Drive
ID	Induced Draft
FD	Forced Draft
PA	Primary Air
MTBF	Mean Time Between Failure
MTTR	Mean Time to Repair
CLIT	Cleaning, Lubrication, Inspection & Tightening

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1. Introduction

Electrotherm (India) Limited is ISO 9001:2015, ISO 14001:2015, OHSMS 45001:2018 & ISO 50001:2018 certified company, Electrotherm (India) Limited is going through an operation excellence activity like Kaizen, Gemba Walk, RCA, 7 QC Tools, KPI, since January-2015 and started getting fruits from very first day.

Even through there is no Linear relationship between boiler load and efficiency, boiler efficiency is very poor both at low load and overload conditions. Efficiency is good at 80-90% loading. Efficiency of boiler depends on design of that boiler, and it should be experimentally determined at what load the boiler efficiency is maximum.

Fig. 1. Layout of the thermal power plant.

2. Methodology to Improve Boiler Efficiency:

In order to improve the efficiency of the boiler and to set the best O&M processes in Electrotherm (Captive Power Center) we have established the following methods:

2.1 Manage Boiler Loads:

Even if there is no direct linear relationship between boiler load and efficiency, boiler efficiency is worse for low loading and overload condition. Good performance at 80-90% upload. The efficiency of a boiler depends on

the construction of a particular boiler and should be determined by testing how much load is operating on the boiler.

2.2 Measure and Manage:

"What we cannot measure properly, we cannot manage properly"

Measure feed water flow, steam flow, fuel flow, pressure and temperature of gas, water and steam in several locations. Measure oxygen in the stack, compare all parameters with design values and identify the problem.

2.3 Monitor and Manage:

Monitor all the parameters mentioned in point (2) and record all the parameters periodically and compare the design parameters. Lower the gap between the design and the performance parameters for a specific load. Monitor specific steam production, special fuel consumption and daily temperature.

2.4 Boiler Tune-up:

Positive configurations using accurate testing equipment can detect and control excessive air, smoking, uncontrolled fuel loss, fire contact and high temperatures. Usually, 3% of the oxygen in the stack shows good tuning. Both high and low levels of oxygen in the stem result in low functioning, and low levels of oxygen in the starch also mean unhealthy and incomplete burns. Electrotherm (I) Ltd. monitors O2 Eco Outlet and continuous monitoring of gas stamp parameters by installing an online gas analyzer.

2.5 Combustion Control:

The total amount of air should be provided to be flammable and that should be automatically controlled by DCS control.

2.6 Low Excess Air Burner:

If the boiler burns gas or oil, then a low-temperature air heater should be used for high efficiency.

2.7 Additives:

Fuel additives help to improve the combustion of all types of boilers, and tests may be performed to determine the appropriate amount of additives to reduce fuel consumption by at least 2%. Electrotherm (India) Limited Uses petrol addiction to increase combustion efficiency.

2.8 Economizer & Air Preheater:

If the boiler is not fitted with an economizer and air preheater, consult an expert to replace the same so that it works more efficiently and saves fuel.

2.9 Soot Blower:

Soot is an excellent insulator, which can slow down heat to a large extent, so soot fuels are used to keep heat exchangers clean and to keep stack temperatures high and efficient. A spray gun or sonic soot blower / sonic horn operator can be used. Sonic Horn is advanced in terms of cost / initial performance, boiler safety and

efficiency. Every 40 ° F a drop in stack temperature saves 1% fuel. Electrotherm (India) Limited Use a sonic horn to keep the heat transfer area clean.

2.10 Blow Down Heat Recovery:

Blow down water temperature depends on pressure inside the boiler, and it contains a lot of energy that can go wasted if it is not put back to work either in the boiler or somewhere else. About 15% of ground water is heated to low pressure, so it is a good source of low pressure and can be used in a deaerator or water heater. This steam can be found in the flash tank and all the heat in the heat exchanger, and the subsequent heating of the water can be used in other applications as part of water conservation measures. Flash steam used in deer to heat Feed Water in Electrotherm (India) Limited.

2.11 Automatic Blow Down Control:

When the temperature is high, high energy explodes uncontrolled water, energy is wasted by dumping excess water in the boiler at a time, which should be replaced by cold cosmetic water. Lack of control can cause the soluble solids and concentrations of silica to rise, creating internal scales that will lead to tube failure, turbine insertion and reduced efficiency. Auto-down controls eliminate these problems and save water, chemicals and energy [1].

2.12 Vent Condensers:

Wherever steam is released into the atmosphere, a respirator can be used to capture this high energy level.

2.13 Increasing Cycles of Concentration of Boiler Water:

Cycles of concentration is the ratio of impurities being maintained in the boiler water to the impurity level of the boiler feed water. A higher cycle of concentration reduces blow down percentage and that improves boiler efficiency. Make sure that you are maintaining correct blow down percentage and cycle of concentration as per design. This is a tricky subject as too high a cycle of concentration may lead to scaling [1].

2.14 Solar Augmentation for Water Heating:

Rule of thumb is that every 10°C rise in feed water temperature increases boiler efficiency by 1%. Makeup feed water is a good candidate for solar augmentation.

2.15 Steam Trap:

Steam traps can waste a lot of energy if they do not work. Even when it works properly, steam traps do not work well, considering the loss of flash. Flash steam can also be detected by a dynamic pumping unit. Significant savings can be achieved with a proper steam trap repair program.

2.16 Condensate Recovery:

By not returning the condensate we release

i. Heat
ii. Water

iii. Chemicals

A steam pump, also called a pressure pump, can be used to replace condensate and light steam.

2.17 Insulation:

Uninsulated hot surfaces are the source of lost energy as well as being a safety hazard. Insulation of bare steam piping is a quick payback item.

2.18 Steam Compression:

If you have low waste pressure and need a high pressure system somewhere far away from the distribution system, then system pressure may help. Screw compressor and steam educator sets developed for steam pressure driven by an electric or main engine type [1].

2.19 Steam Driven Pump and Blowers:

Electric-powered pumps and blowers are usually installed because they are lightweight and require minimal adjustment; however, if the cost of electricity is taken into account, steam-powered app can be very economical. If there is space to use the full volume of steam from a steam-powered machine, then a similar situation exists, where the rejected heat can be used to improve the efficiency of the entire cycle. Steam-powered equipment is especially popular when demand for electricity is very high.

2.20 Cogeneration:

Given the high cost of electricity, it is very expensive to use the mixing industry to supply steam while generating electricity. You can be independent of the grid and improve plant performance by avoiding grid failure.

2.21 Variable Frequency Drive or Adjustable Speed Drives:

Adjustable Speed drive is a proven energy saving method where pumps and fans operate at higher speeds than required for a specific load, The power used varies depending on the speed cube. Significant savings can be achieved by reducing the speed of rotating machinery. Rule 6: If the speed of the pump or the pump is reduced by half, there will be an 88% reduction in power consumption [1].

2.22 Soft Fine Brick in Combustion Chamber:

Light weight firebrick or ceramic fiber material should be considered for combustion chamber. This material heats up faster, taking the combustion zone through its cold smoky period more quickly. This should be considered for low use boilers.

2.23 Sizing of Coal:

Coal balancing is very important for heating and efficiency. Although different types of coal-fired boilers have different charcoal sizes, the atmospheric fluidized bed combustion (AFBC) boiler with a size of 6 mm is perfect. Excessive fines (over 30%) greatly reduce fire efficiency. Too many penalties help the formation of clinker.

Coal of large size reduces the efficiency of combustion and creates the problem of clinker formation. "Install VFD in a coal crusher to reduce coal mines and energy consumption"

2.24 Moisture in Coal or Fuel:

Heavy rains impede the availability of coal and increase moisture in coal. Every 10% increase in humidity in coal reduces the efficiency of boiler by 1% and creates other problems such as system congestion and generation.

2.25 Ash Conveying:

Care must be taken to ensure that the ash from the boiler is transported to the cell properly. There should be a level change in the hopper and alarm system. If the transmission system fails and there is no alarm, then there is a chance that the hoppers will be filled with ashes, and this will eventually pollute the economy or air heaters and reduce the efficiency of the boiler significantly.

2.26 Intermittent Ignition devices:

It does not make sense to keep the flames burning in a boiler when the heat is not needed, it wastes energy. Especially with gas-fired equipment, there are many small boilers with continuous driver flames. 24 hours a day, year after year, these tiny flames can use a lot of heat on BTUs. Occasional igniting technology has been proven to be reliable and safe, so these old-fashioned driving lights should be replaced with fittings. Occasional sewing devices are reliable certified machines. They are designed to regenerate in most boilers and furnaces and are inexpensive. Their payment period is shorter [2].

2.27 Use Flue Gas as Source of Carbon Dioxide:

In some location flue gas, with its high CO2 content, has been used as a source of CO2 for various purposes. This is a novel way to use a waste stream. There need to be a market for the CO2 and the boiler would be a reliable source.

2.28 Turbulators:

Turbulators are a very effective way to reduce stack temperature and increase the efficiency of fire tube boilers. In a hot tub boiler the hot gases must pass through a series of small tubes where the heat is supplied to the side walls causing the gases to slow down and slow down, forming layers of cold gas near the heat exchange. This condition prevents good heat transfer, so turbulators are used to break this protective film [2].

2.29 Heat Re-claimer:

It is heat exchanger installed in the stack with its own pump and regulating valves and is basically an additional heat exchange surface for the heating unit. The flue gas temperature can be controlled by regulating the flow of water through the heat re-claimer. Many of the older boilers have high stack temperature and high excess air levels, making this option very attractive.

2.30 Control Exhaust Draft Conditions:

In many cases the size of the stacks and exhaust systems is exaggerated, allowing unlimited drawings and often excessive misalignment to occur. Larger exhaust systems provide less resistance to different conditions for stacking and cause excess air to be pumped into the heater and facilitates the unlimited escape of large volumes of gases that emit high temperatures. Years ago, the gaps were cut in the stack with the molten metal inserted, but this option was unsatisfactory. A modern adjustable design, a special air-cooled barrier, is designed to show the best results. Install VFD in ID, FD and PA fan to control drafts and remove excess refractory from water wall to reduce ESP Inlet temperatures for Electrotherm (India) Limited boilers [2].

2.31 Autonomous maintenance:

Electrotherm (I) Ltd. we established best practices in maintenance of Critical auxiliaries of power plant. Started monitoring minor and major stoppage by using MTTR and MTBF Tools and improve MTBF and reduce MTTR by applying CLIT Schedule in Every equipment. Trained Operators to do minor maintenance activity and eliminate major breakdown by identifying and solving small variation in machine like, temp. Vibration, noise, leakages etc. (Condition Monitoring) CLIT Schedule of Boiler feed water pump [3].

Efficiency of boiler depends on flue gas outlet temperature so decreasing the flue gas outlet temperature, heat loss decreases. When the temperature decreased by 10°C, the efficiency improved of the boiler by 1%. If the excesses air supplied is very large amount, then the ignition temperature required for combustion of coal is decrease which effect the combustion efficiency of coal is reduced and due to these losses in boiler is maximized & formation of carbon monoxide is increase. Overall plant efficiency is depending on Combustion control optimization Flue gas heat recovery Soot blowing optimization. If Hydrogen % in fuel increases than it will lead to increase in loss due to H_2 in fuel & boiler efficiency will decrease. If there is increasing in the feed water temperature up to 6°C the boiler efficiency will increase up to 1%.

3. Conclusion

In the current study, various parameters were analyzed for the boiler efficiency improvement. The flue gas temperature, excess air supply and the hydrogen percentage in the fuel are the critical parameters for the boiler efficiency. The feed water temperature was enhanced by 1% when the feed water temperature enhanced by around 6ºC. The overall efficiency improvement in the Boiler efficiency up to 81.45% in F.Y 2020-21 was observed in comparison to F.Y 2019-20 of 77.65% by accompanying the suggested changes.

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