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## RESEARCH ARTICLE

### Performance Analysis From The Efficiency Estimation of Coal Fired Boiler

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#### Abstract

Coal fired Boiler is one of the most important components for any Thermal Power Plant. The prominent Performance parameter of a boiler is “Boiler Efficiency”. Boiler Efficiency affects the overall performance of the electricity generation process and as well as plant economy. Boiler efficiency is affected by many factors. It reduces with time, due to various heat losses such as loss due to unburnt carbon in waste, loss due to dry flue gas, loss due to moisture in fuel, loss due to radiation, loss due to blow down, and loss due to burning hydrogen, etc.. Boiler efficiency tests help us to calculate deviations of boiler efficiency from the design value and identify areas for improvement. The current paper puts forward an effective methodology for the efficiency estimation of a coal fired boiler, comparison with its design value and enlists some of the factors that affect the performance of a boiler. This study will help to increase overall boiler efficiency and as a result, annual monetary savings of the thermal power plant.

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#### INTRODUCTION:

The energy demand in India, not unexpectedly, is amongst the lowest in the world on per capita basis. However, for a developing country like ours, we run a very high energy bill. That all efforts must be made to conserve energy is an understatement and even the most modest attempt in this direction is worthy. The energy released from the combustion processes is used to generate process steam in a boiler system. When investigating steam systems the boiler is one of the primary targets for energy efficiency improvement. There are many tools used in the evaluation and management of boiler performance. One of the most useful tools is boiler efficiency. Boiler efficiency describes the fraction of fuel energy that is converted into useful steam energy. Of course, the fuel input energy that is not converted into useful steam energy represents the losses of the boiler operation. Boiler research generally evaluates the losses by identifying the paths of loss, measuring the individual loss, and developing a strategy for loss reduction.

A coal fired boiler is an enclosed vessel that provides a means for combustion heat of coal to be transferred into water until it becomes steam. When water is boiled into steam its volume increases about sixteen hundred times, producing a grander force like explosive that will run the turbine in later processes to generate electricity. This indicates that a boiler is extremely risky equipment that must be treated with supreme care. The process of heating a liquid until it reaches its gaseous state is called evaporation. Heat is transmitted from one body to another mainly by three modes of heat transfer viz. radiation, convection and conduction.

Efficiency testing helps us to find out how far the boiler efficiency floats away from the design efficiency. Any observed irregular abnormalities could therefore be scrutinized to pin down the problem area for necessary counteractive action. Hence it is necessary to find out the current level of efficiency for performance evaluation, which is a mandatory for energy conservation action in industry. It is an indicator for tracking day-to-day and season-to-season variations in boiler efficiency and energy efficiency improvements.

## I. BOILER EFFICIENCY ESTIMATION METHODS:

The efficiency of a coal fired boiler is quoted as the % of useful heat available, expressed as a percentage of the total energy potentially available by burning the coal. This is expressed on the basis of gross calorific value (GCV) of coal.

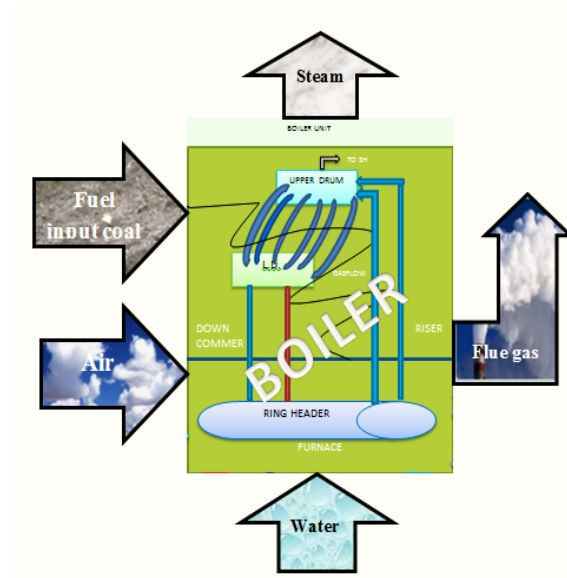
Most standards for calculation of boiler efficiency, including IS 8753, ASME Standard: PTC-4-1 Power Test Code and BS845 are designed for measurement of boiler efficiency. Unvaryingly, all these standards do not include blow down as a loss in the efficiency determination process.

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,

$\eta$  = 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.

Both heat input and heat output must be measured. The accurate measurement of the flow of coal fuel is very difficult. The measurement must be based on mass, which means that bulky apparatus must be set up on the boiler-house floor. Samples must be taken and bagged throughout the test, the bags sealed and sent to a laboratory for

analysis and calorific value determination. In some more recent boiler houses, the problem has been improved by mounting the hoppers over the boilers on calibrated load cells. There are several methods, which can be used for measuring heat output. With steam boilers, an installed steam meter can be used to measure flow rate, but this must be corrected for temperature and pressure.

Pros and Cons of Input Output Method:

Pros:

- Plant engineer can evaluate quickly the efficiency of boilers.
- Requires less parameter for computation.
- Needs few instruments for observation.

Cons:

- Does not give hints to the operator as to why efficiency of system is lower.
- Does not estimate various losses responsible for various efficiency levels.
- Evaporation ratio and efficiency may mislead, if the steam is highly wet due to water carryover.

### **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.

Heat loss method is better to use in practice. The main reasons for that are following.

- It is easier to calculate the losses as compared to measure the flow rate of coal.
- Easy to check the controllable & uncontrollable losses & can do try to reduce the controllable losses.
- Complementary ideas for efficient boiler operation can be generated.
- Efficiency can be improved by combined effect of these entire things.
- It is more accurate as compared to direct method.

Valid losses incorporate with to coal fired boiler:

1. Heat loss due to dry flue gas as sensible heat ( $L_1$ ).
2. Heat loss due to moisture in the coal ( $L_2$ ).
3. Heat loss due to moisture from burning of hydrogen in coal ( $L_3$ ).
4. Heat loss due to moisture in air ( $L_4$ ).
5. Heat loss due to formation of carbon Monoxide- partial combustion ( $L_5$ ).
6. Unburnt losses in fly ash as carbon ( $L_6$ ).
7. Unburnt losses in bottom ash as carbon ( $L_7$ ).
8. Loss due to surface radiation and convection ( $L_8$ ).

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

Boiler efficiency by indirect method:

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

### C. Procedure for Indirect Method or Heat Loss Method:

There are different heat source that are included inside the boiler system viz. heat content in the entering air, sensible heat of the fuel, pulverizer or crusher power, boiler circulating pumps, Recirculating gas fan power ( ID & FD fan, OFA fan).

<b>Instrument</b>	<b>Type</b>	<b>Measurements</b>
<b>Flue gas analyzer</b>	Portable or fixed	% CO <sub>2</sub> , O <sub>2</sub> and CO
<b>Temperature indicator</b>	Thermocouple, liquid in glass	Fuel temperature, flue gas temperature, combustion air temperature, boiler surface temperature, steam temperature
<b>Draft gauge</b>	Manometer, differential pressure	Amount of draft used or available
<b>TDS meter</b>	Conductivity	Boiler water TDS, feed water TDS, Make-up water TDS.
<b>Flow meter</b>	As applicable	Steam flow, water flow, fuel flow, air flow

Collection and Analysis of different samples required for indirect method of testing:

- Flue gas temperature at air heater outlet.
- Dry & wet bulb temperature of ambient air.
- Flue gas analysis for O<sub>2</sub>, CO<sub>2</sub>, CO & Excess air.
- Relative humidity from psychometric chart.
- Front ash temperature at furnace outlet
- Coal sampling is done with the collected sample, proximate and ultimate analysis is carried out with standard formula.
- Ash sample collected is analyzed for unburned carbon.
- Bottom & fly ash sampling.

In order to calculate the boiler efficiency by indirect method, all the losses that occur in the boiler must be established. These losses are conveniently related to the amount of fuel burnt. In this way it is easy to compare the performance of various boilers with different ratings.

Conversion formula for proximate analysis to ultimate analysis:

$$\%C = 0.97 \times FC + 0.7(\text{VM} + 0.1 \times A) - M (0.6-0.01 \times M).$$

$$\%N = 2.10 - 0.020 \times \text{VM}.$$

$$\%H = 0.036 \times FC + 0.086(\text{VM} - 0.1 \times A) - 0.0035 \times M^2 (1-0.02 \times M)$$

$$\%O = 100 - (\%C + \%H + \%N)$$

Where,

**C**- Carbon content. **A**- Ash. **H**- Hydrogen. **O**- Oxygen. **VM**-Volatile Matter. **TM**- Total moisture.  
**FC**- Fixed Carbon.

## THE VARIOUS HEAT LOSSES AND THEIR THERMODYNAMIC RELATION:

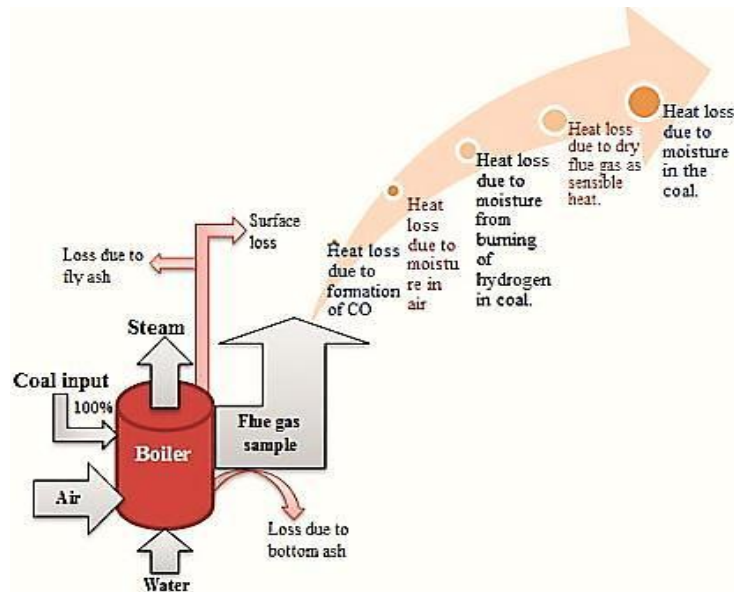


FIGURE 2: DIFFERENT HEAT LOSSES ASSOCIATED WITH BOILER

Different terms used:

$m$  = weight of dry flue gas, kg/kg of coal,

$C_{p1}$  = specific heat of flue gas in kCal/kg °C, usually 0.24

FGT = the flue gas temperature, °C

AAT = the ambient air temperature, °C

GCV = the higher heating value of the fuel, kCal/kg.

$H_2$  = weight fraction of hydrogen in the ultimate analysis of the fuel = kg of hydrogen present in fuel on 1kg basis.

$C_{p2}$  = specific heat of superheated steam in kCal/kg °C

AAT = the ambient air temperature, °C  
 $584$  = latent heat for corresponding partial pressure of water vapour in kCal/kg.

$M$  = kg of moisture present in fuel on 1kg basis.

CO = volume of CO in flue gas leaving economizer in %.

CO<sub>2</sub> = actual volume of CO<sub>2</sub> in flue gas in %.

$C$  = carbon content kg/kg of fuel.

FC = Fuel consumption in kg/hr.

AMA = Actual mass of air supplied per kg of fuel.

HF = Humidity Factor =  $\frac{\text{kg of water}}{\text{kg of dry air}}$

TAC = total ash collected per kg of fuel burnt.

### 1. Heat loss due to dry flue gas:

This is the greatest boiler loss and can be calculated with the following formula

$$L_1\% = \frac{[m \times (C_p)_1 \times (FGT - AAT)]}{GCV \text{ of coal}} \times 100\%$$

Where,

$m$  = combustion products from fuel: CO<sub>2</sub> + SO<sub>2</sub> + nitrogen in fuel + nitrogen in the actual mass of air supplied + O<sub>2</sub> in flue gas. (H<sub>2</sub>O/water vapours in the flue gas should not considered)

For Quick and simple calculation of boiler efficiency use the following. Simple method can be used for determining the dry flue gas loss as given below

$$\text{dry flue gas loss \%} = \frac{[m \times C_{p1} \times (FGT - AAT)]}{GCV\text{of coal}} \times 100\%$$

Total mass of flue gas (m)/kg of fuel = mass of actual air supplied/kg of fuel + 1 kg of fuel.

**2. Heat loss due to evaporation of water formed due to H<sub>2</sub> in fuel (%):**

$$L_2\% = \frac{[9 \times H_2 \times \{584 + C_{p2} \times (FGT - AAT)\}]}{GCV\text{of coal}} \times 100\%$$

**3. Heat loss due to moisture present in fuel (%):**

This moisture loss is made up of the sensible heat to bring the moisture to boiling point, the latent heat of evaporation of the moisture, and the superheat required bringing this steam to the temperature of the exhaust gas.

$$L_3\% = \frac{M\{584 + C_{p2} \times (FGT - AAT)\}}{GCV\text{of coal}} \times 100\%$$

**4. Heat loss due to moisture present in air (%):**

Vapour in the form of humidity in the incoming air, is superheated as it passes through the boiler. Since this heat passes up the stack, it must be included as a boiler loss.

$$L_4\% = \frac{AMAxHF \times C_{p2} \times (FGT - AAT)}{GCV\text{of coal}} \times 100\%$$

**5. Heat loss due to partial combustion (%):**

The generated products by partial include CO, H<sub>2</sub>, and various hydrocarbons and are generally found in the flue gas of the boilers. CO is the only gas whose concentration can be determined appropriately in a boiler efficiency testing process.

$$L_5\% = \frac{\%CO \times C}{\%CO + \%CO_2} \times \frac{5744}{GCV\text{of coal}} \times 100\%$$

When CO in ppm,

$$L_5\% = \text{CO in ppm} \times 10^{-6} \times FC \times 28 \times 5744$$

**6. Heat loss due to radiation and convection (%):**

The actual radiation and convection losses are difficult to assess because of particular emissivity of various surfaces, its inclination, air flow pattern etc. Normally surface loss and other unaccounted losses is assumed based on the type and size of the boiler as given below:

For industrial fire tube / packaged boiler = 1.5 to 2.5%

For industrial water tube boiler = 2 to 3%

For power station boiler = 0.4 to 1%

**7. Heat loss due to unburnt in fly ash (%):**

Small amounts of carbon will be left in the ash and this constitutes a loss of potential heat in the fuel. To assess these heat losses, samples of ash must be analyzed for carbon content.

$$L_7\% = \frac{TAC \times GCV \text{ of fly ash}}{GCV \text{ of coal}} \times 100\%$$

**8. Heat loss due to unburnt in bottom ash (%):**

$$L_8\% = \frac{TAC \times GCV \text{ of bottom ash}}{GCV \text{ of coal}} \times 100\%$$

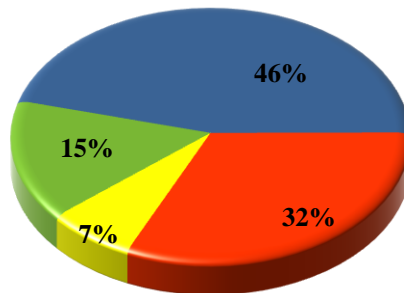
**II. BOILER EFFICIENCY ESTIMATION**

Based on standard coal sample efficiency of the coal fired boilers evaluated by both Direct and Indirect methods and depicted in upcoming tables. Here all the data and parameters are measured and depicted for 24-hours. A coal fired boiler is selected for the estimation.

Boiler Description	Working Pressure	Steam Temperature, °C
Coal Fired Stoker Boiler	60Kg/ Cm <sup>2</sup>	400

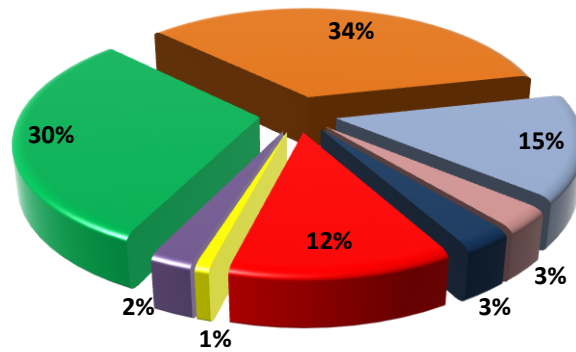
**Proximate Analysis of standard coal sample:**

- Fixed Carbon
- Volatile Matter
- Ash
- Moisture



**Ultimate Analysis of standard coal sample:**

- Hydrogen
- Sulphur
- Ash
- oxygen
- Volatile Matter
- Moisture
- Nitrogen
- Fixed Carbon



Calorific value of coal estimated based on the test parameters with the below mentioned equation.

$\text{GCV (kCal/kg)} = 85.56 (100 - 1.1 A + M) - 60 M \quad (\text{Moistures above } 2\%)$
$\text{GCV (Kcal/kg)} = 91.67 \text{ FC} + 75.56(\text{V M} - 0.1 A) - 60 M \quad (\text{Moisture Below } 2\%)$

GCV of coal sample = 4525 kcal/kg (Value taken for boiler efficiency calculation)

**Table 2: Efficiency estimation by Direct Method**

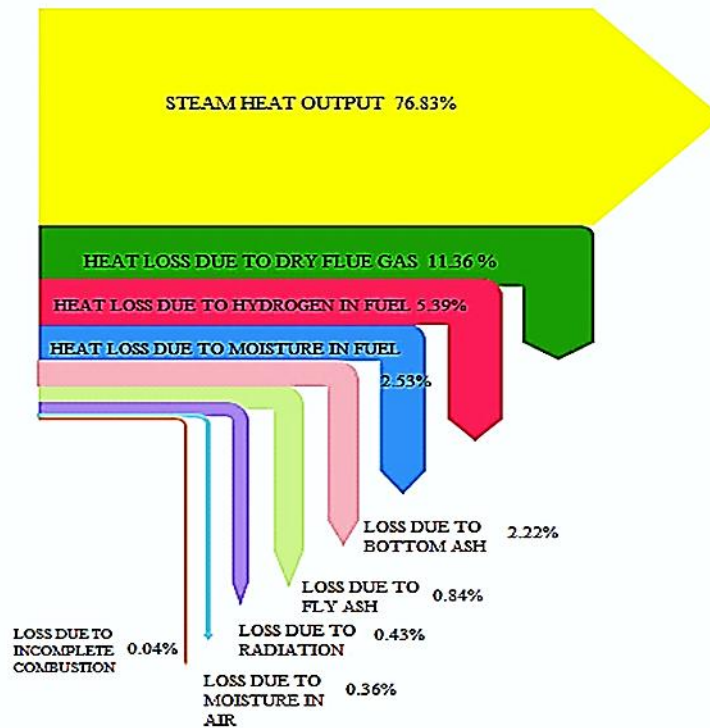
Particulars	Unit	Boiler values
Operating Hours	hr	24
Steam Pressure	kg/cm <sup>2</sup>	60
Steam Temp	°C	
Steam outlet	Tons/day	1131
Coal Consumption	Tons/day	195
calorific Value (GCV)	kcal/kg	4525
Evaporation Ratio	Kg <sub>steam</sub> / Kg <sub>coal</sub>	5.80
Feed water Inlet Temperature	°C	85
Feed water Flow rate	m <sup>3</sup> /hr	65
Ambient Temperature	°C	36.8
Enthalpy of HP steam	kcal/kg	758
Enthalpy of Feed water	kcal/kg	90
<b>Efficiency (Direct Method)</b>	<b>%</b>	<b>85.62</b>

**Table 3: Parameters for efficiency estimation by Indirect Method**

Particulars	Unit	Boiler values
Gas Temperature	°C	217.5
O <sub>2</sub>	%	10.6
CO <sub>2</sub>	%	9.2
Excess Air	%	103
CO	%	0.007
NO	ppm	180
SO <sub>2</sub>	ppm	1642
No <sub>x</sub>	ppm	375
Moisture (open storage)	%	15-20
Avg. Surface Temp. of Boiler	°C	64.7
Wind velocity around the boiler	m/s	3.1
Total Surface area (Approximate)	m <sup>2</sup>	300
GCV fly ash	kcal/kg	453
Ash in coal	%	31
Bottom Ash to fly Ash	%	40:60
GCV of Bottom ash	kcal/kg	800
Theoretical Air Requirement	kg/kg of Coal	5.51
Measured Excess Air	%	101.92
Moles of N <sub>2</sub>	Moles	0.22
Moles of C	Moles	0.03
Theoretical CO <sub>2</sub>		13.32
Mass of dry flue gas	Kg of dry flue gas/kg	11.370

**Table 4: Boiler Heat Balance**

<b>BOILER HEAT BALANCE</b>		
Particulars	Unit of Coal	Boiler values
<b>Losses</b>		
1. Heat Loss due to dry flue gas	%	11.36
2. Heat Loss due to Hydrogen in fuel	%	5.39
3. Heat Loss due to Moisture in fuel	%	2.53
4. Heat loss due to Moisture in air	%	0.36
5. Heat Loss due to incomplete combustion	%	0.04
6. Loss due to radiation	%	0.43
7. Loss due to fly ash	%	0.84
8. Loss due to bottom ash	%	2.22
Total Loss	%	23.17
<b>Boiler Efficiency (100- Total Loss)</b>	<b>%</b>	<b>76.83</b>



**FIGURE 3: SANKEY DIAGRAM SHOWING HEAT BALANCES OF BOILER**

Here  $O_2$  level in the flue gas is quite high when compared to the normal recommended value of 4 % (lesser  $O_2$  level would ensure a good combustion temperature and at the same time restrict the heat loss to atmosphere through flue gas). Direct method efficiency is about 85.62%, which is near the optimum level. For indirect method, the flue gas measurements were taken on the ID fans suction side and economizer outlet.

### III. COMPARISON BOILER EFFICIENCY WITH DESIGN VALUE

The above mathematical calculation to determining the actual heat losses in boiler by using indirect method. Results obtained from this work shows that the boiler efficiency for a coal fired stoker boiler is about 76.83 %. The 23.17% of the energy is wasted .While for this same boiler the rated design efficiency 83.37% and total losses are 16.63%. To find causes behind above losses and degradation in efficiency detailed analysis and some appropriate maintenance strategy should be adopted.

### IV. PERFECTIONS TO EXISTING BOILER

It may not be always cost-effective to replace boilers. However, there are still opportunities to make substantial savings through improvements to other items of the boiler plant.

#### A. Insulate boilers, pipework and valves:

Heat loss through the boiler, pipework and valves leads to poor efficiency. The boiler insulation should be assessed and replaced where it is insufficient or showing signs of degradation. Similarly, the insulation on the associated boiler pipework and valves should be assessed and replaced if necessary. This can result in additional savings of up

to 10% of the boiler energy input. Modern valve-wraps solve this problem by providing suitable levels of insulation but allow easy access to the valve through quick-release fastenings.

#### **B. Fit flue dampers:**

On larger boilers, the flue can cause a flow of air through the boiler, even when it is not firing. This cools the boiler and valuable heat is lost to the atmosphere – known as ‘standing losses’. A flue damper can be used to close off the flue automatically when the boiler is not firing, thus preventing this energy loss. To improved efficiencies at both full and part-loads, and this has led to lower standing losses in modern boilers. Retrofitting flue dampers are applicable to older, conventional boilers with a large load.

#### **C. Install variable speed drives and pumps:**

On forced/induced-draught boilers, a variable speed drive can be installed on the fan to operate at lower speeds when less air flow is required. A reduction in fan speed of just 10% can result in fan energy consumption savings of around 20%, and a reduction in fan speed of 20% will save up to 40%. This is particularly relevant for big boiler systems.

#### **D. Recover heat from exhaust gases:**

Heat can be recovered from exhaust gases through the use of a device like air preheater, economizer. The heat can be used to pre-heat the return water or the combustion air. Increasing the temperature of the combustion air by 20 °C can improve the overall efficiency of the boiler by 1%.

### **V. CONTROLLING OF BOILERS**

Boiler control:

- Improvement in existing control.
- Installation of new beneficial control.

#### **A. Burner controls:**

Burner controls manage the fuel-to-air ratio which is critical to the efficient operation of the boiler: too little air and there will not be enough oxygen for complete combustion to occur resulting in a build-up of potentially dangerous CO in the flue; too much air and energy will be wasted in trying to heat the excess.

#### **B. Types of burner control:**

The simplest form of burner control is single stage or ‘on-off’ control. With this type of control, the burner fires at full capacity when heat is required and is off otherwise. Air purges immediately before the burner is switched on and after the burner is switched off to ensure that no residual fuel or combustion vapour remains in the boiler, but this also causes heat to escape via the flue. An improvement to the above is two-stage or ‘high-low’ control. With this type of control, rather than being completely switched off, the burner has the option of going to a low firing rate, typically 40% of full capacity. This reduces the number of times the burner switches off and the number of air purges, and improves boiler efficiency under part-load conditions. A further improvement is modulating control. With this type of control, the fuel and air supplies are regulated to exactly match the required heat demand. This ensures good efficiency across the whole heat output range of boilers. Modern burners typically use microprocessors based controls. These adjust air and fuel flows continuously, compensating for changing conditions to ensure that the correct fuel-to-air ratios are maintained accurately. Retrofitting of burner controls is best suited for older, conventional boilers with large, variable heat loads.

#### **C. Boiler Interlock:**

Boilers can continue to fire even when there is no demand for heat (called dry-cycling) and so all the heat energy is lost to the flue. Find out whether this is happening by turning off the heat distribution system and then observing the

boilers themselves. If they continue to fire when no load is required, dry-cycling is occurring. Clearly this should be avoided.

**D. Sequence Control:**

If there are two or more boilers, it is a good idea to consider sequence control if it is not already installed. Find out whether or not sequence control is operating by observing the boilers during part-load conditions, such as in spring or autumn. If all boilers are firing and shutting down simultaneously, it is likely that they are operating only at part load and do not have sequence control. Good sequence control ensures that only the minimum number of boilers required meeting the heat demand fire and that these boilers are used at their optimum efficiency load.

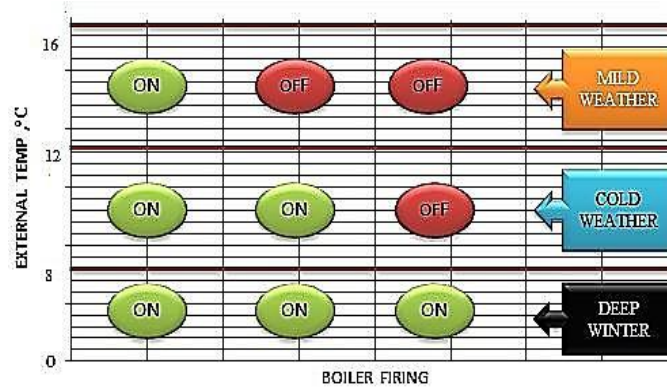


FIGURE 4: SEQUENCE CONTROL

**E. Building Energy Management Systems:**

A Building Energy Management System (BEMS) is a computer-based control system which automatically monitors and controls a range of building services.

**F. Direct Weather Compensation Control:**

To achieve more savings, the temperature of the water can be regulated according to outside temperature. In milder weather, the flow temperature is reduced, thus saving energy. This is done through the use of a compensator linked to internal and external thermostats. This form of control is particularly useful in condensing boilers as lower return water temperatures can be achieved, thus ensuring that maximum condensation occurs within the boiler and increasing efficiency.

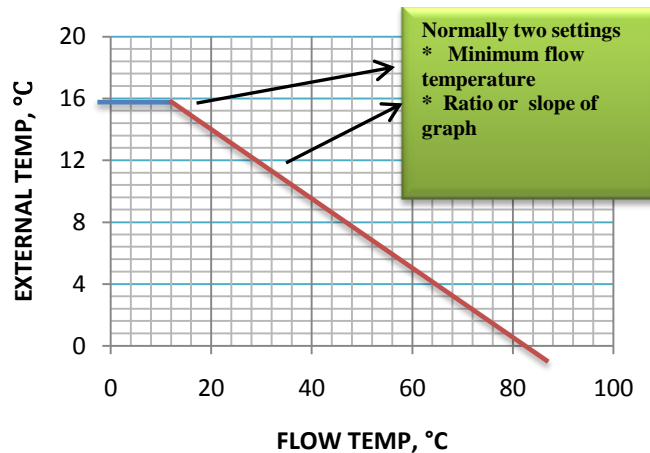


FIGURE 5: SHOWING DIRECT WEATHER COMPENSATION CONTROL

## **VI. 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.

### **A. Perform regular servicing:**

A full boiler service should be carried out on an annual basis, ideally before the start of the summer season. This service should include a flue gas analysis (to check fuel-to-air ratio), an operational check, controls calibration, burner cleaning and lime scale treatment.

### **B. Analyse flue gas:**

Analysis of the boiler's flue gases for levels of carbon dioxide (CO<sub>2</sub>), oxygen (O<sub>2</sub>) and carbon monoxide (CO) will determine whether this ratio is correct and what adjustments need to be made. Flue gas analysis should be carried out typically for every three months and the combustion efficiency which includes measures for improving it.

### **C. Soot removal:**

If combustion conditions are not correct, particularly if too little air is used, fuel combustion will not be complete. So excessive amounts of CO and particles of carbon (soot) will form. If these particles build up on the fire side of the boiler's heat exchanger they will form an insulating layer, inhibiting heat transfer to the water. More heat input is required to meet the heat demand and more heat energy will be lost to the flue. Fossil fuel like coal is more likely to form soot and should be carefully monitored. A 1 mm layer of soot will cause a 10% increase in energy input to the boiler to meet the same heat demand. Integrated soot-blowers are often installed in boilers to provide continual cleaning; however, these will need to be checked regularly to ensure good working.

### **D. Minimise limescale build-up:**

In hard water areas, limescale can build up on the water side of the boiler's heat exchanger. This creates an insulating layer, preventing heat transfer to the water in the same way as the soot deposits. The most effective method of limescale removal is through chemical treatment of the water. This should be done annually to minimise limescale build-up and keep your boiler running at its most efficient.

### **E. Produce a maintenance plan, manual and logbook:**

To ensure effective maintenance is carried out, a maintenance plan should be put in place. This will detail what maintenance tasks are to be carried out, the frequency of these tasks and who is responsible. A maintenance manual should be produced that is updated regularly. A maintenance logbook should be kept giving detailed records of maintenance tasks, including which actions were taken, the person responsible, and when they were completed. This logbook will ensure that tasks are carried out at the correct frequency and will highlight ongoing problems.

### **F. Boiler Replacement:**

The potential savings from replacing a boiler depend on the anticipated change in overall efficiency. A change in a boiler can be financially attractive if the existing boiler is:

- Old and inefficient.
- Not capable of firing cheaper substitution fuel.
- Over or under-sized for present requirements.
- Not designed for ideal loading conditions.

The feasibility study should examine all implications of long-term fuel availability and business growth plans. 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.

## VII. CONCLUSION

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.

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