

Exploitation the method of direct testing is shown within the figure.

The Indirect technique Testing

The disadvantages of the direct technique will be overcome by this technique, which calculates the varied heat losses associated with boiler. The varied losses that had occurred in the boiler are shown within the Figure three. The potency can be acquired, by subtracting the warmth loss fractions from a hundred. An important advantage of this method is that the errors in measuring don't build significant modification in potency.

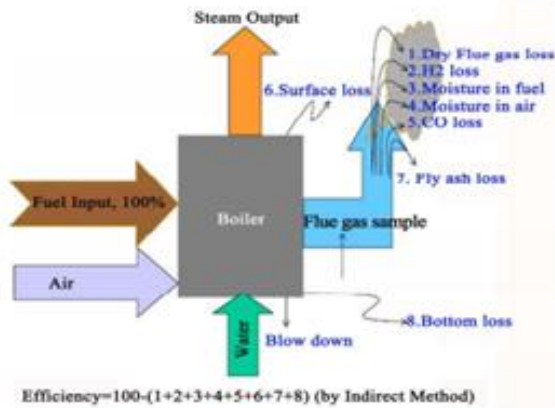


Figure 2: Losses occurring in the boiler

Thus if boiler potency is ninety, a slip of a hundred and twenty fifth in direct method can end in important modification in potency. i.e. $90 \pm 0.9 = 89.1$ to 90.9 . In indirect technique, 1% error in measuring of losses can end in potency = a hundred - $(10 \pm 0.1) =$ ninety \pm zero.1 = 89.9 to 90.1 . So as to calculate the boiler potency by indirect technique, all the losses that occur within the boiler should be established. These losses are handily associated with the number of fuel burnt. Theoretical (stoichiometric) air-fuel magnitude relation and excess air supplied square measure to be determined 1st for computing the boiler losses.

Efficiency of boilers in steel plant is calculated by Indirect Method and a sample calculation is shown below. The Heat balance sheet is also prepared. The calculations are shown along with the heat balance sheet. The parameters are obtained from the shift operator log book from Main Control Room, TPP.

C. Experimental Parameters

One of the indicators which show the development and living standards a community is Exergy Consumption. The performance of the boiler is evaluated through exergetic performance criteria which are based on 2nd law of thermodynamic. The exergy destruction and exergy efficiency analysis will provide and improve the plant efficiency.

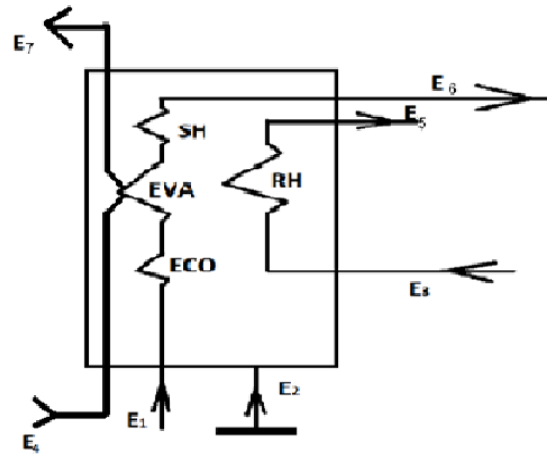


Figure 3: Showing energy and exergy input-output balancing:

Boiler efficiency:-

$$\text{Boiler efficiency} = \frac{\text{steam flow rate} \times (\text{steam enthalpy} - \text{feedwater enthalpy})}{\text{fuel input}} \times 100$$

Fuel firing rate calorific value of fuel

$$\text{Boiler} = m_s (h_2 - h_1) + m_r (h_4 - h_3) / (m_f) \times \text{LHV}$$

Exergy analysis:-

$$\text{Exergy in } (E_{in}) = E_1 + E_2 + E_3 + E_4$$

$$\text{Exergy out } (E_{out}) = E_6 + E_5 + E_7$$

$$\text{Work input } (W_{in}) = W_{fan} = 1978 \text{ kW}$$

$$\text{Exergy destruction } (E_d) = W + E_{in} - E_{out}$$

$$\% \text{ Energy Destruction } (E_d)$$

$$= \frac{E_d}{W_{fan} + E_{in}} \times 100$$

Second law efficiency:-

$$(\text{Efficiency}) E_{II} = \frac{E_{out}}{W_{fan} + E_{in}} \times 100$$

5. Analysis Results

Performance and Exergy Destruction Analysis of Boiler

In this thesis the boiler of power plant was (8 & 12) analyzed using the above relation on the environment reference temperature and pressure are 298.15K and 1.013 bar respectively. The distribution of exergy addition, exergy losses and exergy consumption for boiler has been worked out on the basis of analysis exergetic efficiency for boiler, has been calculated.

Calculation

$$\text{Work input } (W_{in}) = W_{fan} = 1978 \text{ kW}$$

$$\text{Exergy in } (E_{in}) = 1562628.12 \text{ kW}$$

$$\text{Exergy out } (E_{out}) = 575487.82$$

$$\text{Exergy destruction } (E_d) = W_{fan} + E_{in} - E_{out}$$

$$= (1978 + 1562628.12) - 575487.82$$

$$= 989118.3 \text{ kW}$$

$$\% \text{ Energy Destruction } (E_d) = \frac{E_d}{W_{fan} + E_{in}} \times 100$$

$$= \frac{989118.3}{1978 + 1562628.12} \times 100$$

$$= 63.218\%$$

$$(\text{Efficiency}) E_{II} = \frac{E_{out}}{W_{fan} + E_{in}} \times 100$$

$$= \frac{575487.82}{1562628.12 + 1978} \times 100$$

$$= 36.781\%$$

It is clear that the boiler shows 36.781 % exergy efficiency and 63.218 % exergy destruction.

Performance of boiler with the usage of different grades of coal in the power plant:

It is notify that as the grade of coal used in the (8) power plant is changed, a change in exergetic efficiency and exergy destruction of Boiler. This type of change in performance is mainly due to inability of the components to harness the exergy thus leading to higher exergy destruction and low exergetic efficiency.

Calculation:

For Bituminous 1:

$$\text{Work input } (W_{in}) = W_{fan} = 1978 \text{ kW}$$

$$\begin{aligned} \text{Exergy destruction } (E_d) &= W + E_{in} - E_{out} \\ &= (1978 + 1069033) - 572702.2 \\ &= 498308.8 \text{ kW} \end{aligned}$$

$$\begin{aligned} \text{(Efficiency) } E_{II} &= \frac{E_{out}}{W_{fan} + E_{in}} \times 100 \\ &= \frac{572702.2}{1069033 + 1978} \times 100 \\ &= 53.473\% \end{aligned}$$

For Bituminous 2:

$$\text{Work input } (W_{in}) = W_{fan} = 1978 \text{ kW}$$

$$\begin{aligned} \text{Exergy destruction } (E_d) &= W + E_{in} - E_{out} \\ &= (1978 + 973776) - 572575.7 \\ &= 403178.3 \text{ kW} \end{aligned}$$

$$\begin{aligned} \text{(Efficiency) } E_{II} &= \frac{E_{out}}{W_{fan} + E_{in}} \times 100 \\ &= \frac{572575.7}{1978 + 973776} \times 100 \\ &= 58.680\% \end{aligned}$$

For Indonesia:

$$\text{Work input } (W_{in}) = W_{fan} = 1978 \text{ kW}$$

$$\begin{aligned} \text{Exergy destruction } (E_d) &= W + E_{in} - E_{out} \\ &= (1978 + 1358847) - 573553.9 \\ &= 787271.1 \text{ kW} \end{aligned}$$

$$\begin{aligned} \text{(Efficiency) } E_{II} &= \frac{E_{out}}{W_{fan} + E_{in}} \times 100 \\ &= \frac{573553.9}{1978 + 1358847} \times 100 \\ &= 42.147\% \end{aligned}$$

For A Grade:

$$\text{Work input } (W_{in}) = W_{fan} = 1978 \text{ kW}$$

$$\begin{aligned} \text{Exergy destruction } (E_d) &= W + E_{in} - E_{out} \\ &= (1978 + 1562629) - 575486.8 \\ &= 989120.2 \text{ kW} \end{aligned}$$

$$\begin{aligned} \text{(Efficiency) } E_{II} &= \frac{E_{out}}{W_{fan} + E_{in}} \times 100 \\ &= \frac{575486.8}{1978 + 1562629} \times 100 \\ &= 36.781\% \end{aligned}$$

We find that the best exergetic efficiency of the boiler is seen when bituminous coal is used. This is mainly because of low exergy destruction, while for higher grades of coal there is poorer combustion leading to poor exergetic

efficiency. The GCV (kcal/kg) value is 3500, 4000. 5500 & 6454 kcal/kg for different type of coal which used in the boiler and graphical representation is given blow:

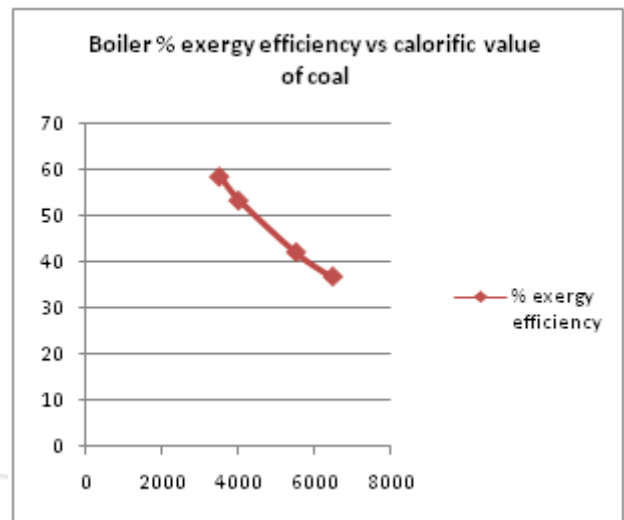


Figure 4: Graphical representation of the variation of highest exergetic efficiency of 58.680% is obtained for calorific value of 3500 kJ/kg while efficiency of 36.781% is observed for calorific value of 6454 kJ/kg

We find that highest exergy efficiency of 58.680% is obtained for calorific value of 3500 kJ/kg while efficiency of 36.781% is observed when high grade coal with calorific value of 6454 kJ/kg is used.

6. Conclusions

Exergy analysis gives entropy generation, irreversibility percentage exergy loss and second law efficiency. The exergy loss or irreversibility is maximum at boiler. Thus to know about actual flow of exergy in the cycle thermodynamic analysis based on second law is desirable.

In the present work a exergy analysis of operating condition of boiler has been carried out based on mass and exergy balance.. It has been found that maximum exergy destruction occurs due to combustion process. Also there is significant exergy destruction occurs in the boiler pressure parts.

Exergy destruction and exergy efficiency of the boiler are presented in Table 1 and corresponding temperature comparison diagram is shown in Table 2. Exergy efficiency of boiler is 36.781 % according to second law analysis and the best exergetic efficiency of the boiler is seen when bituminous coal is used. This is mainly because of low exergy destruction, while for higher grades of coal there is poorer combustion leading to poor exergetic efficiency that highest exergetic efficiency of 58.680% is obtained for calorific value of 3500 kJ/kg while efficiency of 36.781% is observed when high grade coal with calorific value of 6454 kJ/kg is used

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