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Energy Saving in a 10 TPH Boiler using Flash Steam

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Abstract—*"The temperature of feed water has a considerable impact on the energy saving in the boiler house of the industry. The calculation of this paper is based on a low pressure 10 TPH boiler installed in a solvent extraction plant under consideration. In that plant the flash steam of the process has diverted from existing path and could be used in another way to increase the feed water temperature and the efficiency of the boiler and more fuel saving is possible.".*

Index Terms*: Boiler efficiency, Feed water temperature, Fuel saving.*

1. INTRODUCTION

The objective of this exercise is to introduce the technical department to the passible energy saving in the boiler section by the utilization of the flash steam and with the help of that the possible improvement in the feed water temperature.

Boiler is just like a heart of Solvent Extraction Plant because almost activities i.e.: "cooking, expanding, extraction, distillation, drying, recuperation even cooling also" requires the proper steam for the maintaining desired Temperature and vacuum.

At the unit under consideration there are 2 no. of boilers (one is Thermal another is Chemo). Each boiler having capacity of 10 MT/h generation of steam. Main fuel of boiler is coal but there is also arrangement of use Agro waste (Husk) as boiler fuel to reduce the Stem cost

2. METHODOLOGY

The plant under consideration is installed with two boilers of 10 TPH capacity as following details:

Table 1

Make	Thermax	Cheema
Type	FBC (under bed)	FBC(under bed)
Year	2008	2008
Boiler Capacity	10TPH	10TPH
Design Pressure	17.5kg/cm^2	17.5kg/c^2
Number of bed	2	1
Bed temperature	856^{0}c,865^{0}c	856^{0}c,865^{0}c
Operating Pressure	14-15kg/cm^2	14kg/cm^2
Normal steam load	7 TPH	
Steam Outlet line size	150NB	
Fuel/Day	35 ton/day	
Fuel Used	Coal	
Calorific Value of Fuel kcal/kg	4200kcal/kg	4200Kcal/kg
Cost of Fuel Rs. /kg	Rs 4.5/kg	
Feed Water Quality	RO water	
Feed Water Temperature	60	60
Feed Water TDS	110ppm	110ppm
Feed Water Ph	7.5	7.5
Blow down frequency	1/day	1/day
Blow down duration	2 minutes	2 minutes
Blow down TDS	3000ppm	3000ppm
Blow down valve size	40NB	
APH (Yes/No)	Yes	
Economizer (Yes/No)	No	
Stack temperature	256 deg C	256 deg C
Temp. after APH	160 deg C	160 deg C

The boiler is running with RO water which has following reports

Table 2

Feed Water Quality	RO water
Feed Water Temperature	60
Feed Water TDS	110
Feed Water Ph	7.5
Total hardness	2

As the feed water temperature at present is 60^0C and arrangement of the feed water tank is as following

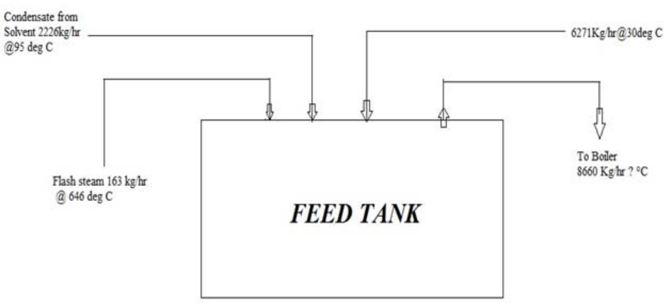

Fig. 1

Temperature of condensate $\mathbf{T_{cw}}$ = 95 deg C

Mass flow condensate water $\mathbf{M_{cw}}$ = 2226kg/hr

Temperature of makeup $\mathbf{T_{mak}}$ = 30degC

Mass flow of make up water $\mathbf{M_{mak}}$ **=** 6271 kg/hr

water flow rate to boiler $\mathbf{M_{fw}}$ = 8660 kg/hr

Mass of flash sream $\mathbf{M_{flash}}$ **=** 163 kg/hr

Temperature of flash steam $\mathbf{T_{flash}}$ **=** 646^oC

All data are measured from the existing running condition of the plant.

At present the condensate water is separated from the flash steam and the flash steam is directly supplied to the feed tank which could not be so considerable effect on the temperature of feed water due to very low pressure and the supply line is very long so most of the steam has been flashed by the float and traps installed in the supply line.

By Heat balance of feed water tank.

$\mathbf{T_{mak} \; X \; M_{mak} + T_{cw} \; X \; M_{cw} + T_{flash} \; X \; M_{flash} = T_{fw} \; X \; M_{fw}}$ [1]

(30 X 6271) + (95 X 2226) + (646 X 163) = $\mathbf{T_{fw}}$ X 8660

$\mathbf{T_{fw} = 59^0 \; C}$

So the present feed water temperature is $\mathbf{T_{fw}} = 59^0$ C and if the path of flash steam is diverted to the condensate that means it will mixed with the condensate then it results the increase the condensate water temperature as well as in the flow rate of the same by a considerable amount. This theory is applied to the same plant and following outcome has been observed:-

Temperature of condensate $\mathbf{T_{cw}}$ = 164.2 deg C

Mass flow condensate water $\mathbf{M_{cw}}$ = 2389kg/hr

Temperature of makeup $\mathbf{T_{mak}}$ = 30degC

Mass flow of make up water $\mathbf{M_{mak}}$ **=** 6271 kg/hr

water flow rate to boiler $\mathbf{M_{fw}}$ = 8660 kg/hr

Again heat balance of feed water tank (proposed)

T_{mak} X M_{mak} + T_{cw} X M_{cw} = T_{fw} X M_{fw}

(30 X 6271) + 164.2 X 2389) = T_{fw} X 8660

$T_{fw} = 67.86^0$ C

The proposed scheme of feed water tank is shown as follows

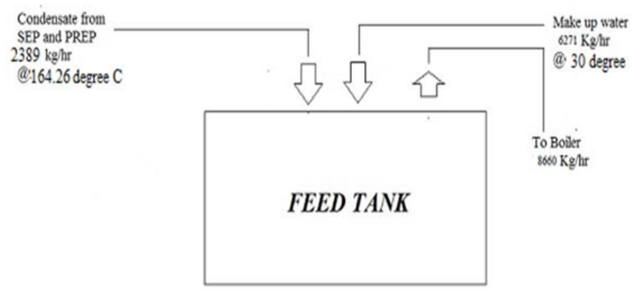

Fig. 2

So it has been clearly observed that the feed water temperature has increased by a significant amount that will result in the fuel saving of the plant and further improvement in the boiler efficiency.

Existing efficiency of the plant is as follows:-

Observation from plant-

Steam temperature = 200 ^{o}C
Feed water temperature = 60 ^{o}C
Mass of steam = 10560 kg /hr
Mass of coal consumed = 2250 kg/hr

$$\text{Boiler efficiency} = \frac{\text{Steam generated X } (H_s - H_{fw}) \text{ X } 100}{\text{Fuel consumed X GCV}} \quad [2]$$

$$= \frac{10560 \text{ X } (666-60) \text{ X } 100}{2250 \text{ x } 4200}$$

= 67.38 %

Now if the feed water temperature is increased from 60°C to 67.86 °C then the fuel consumption at direct efficiency = 67.38%

$$\text{Mass of fuel} = \frac{10560 \times (666-67) \times 100}{67.38 \times 4200} = 2235 \text{ kg}$$

So the fuel saving by increasing the feed water temperature = 2250-2235 = 15 kg /hr

So the total saving in a day if the plant running 24 hours

= 15 X 24 = 360 kg/day

So saving in year = 360 X 365 = 131400 kg /annum

If one kg coal cost is 4.5 Rs/kg

Than saving in rupees = 131400X 4.5 = 5.9 lakh/annum

3. CONCLUSION

The increase in the feed water temperature by utilisation of flash steam in a correct manner will increase the performance of the boiler and directly reduce the coal consumption. It will give a considerable energy saving in the boiler house will results the saving of approximately 5.9 lakh/annum.

Outcome of the report

Table 3

Sr no.	Feed water temperature °C		Coal consumption Kg/hr		Fuel saving Kg/hr
	Present	Proposed	Present	proposed	
1	60	67.86	2250	2235	15

Also there are some more points which needs to be in under consideration for the efficient operation of the boiler plant are:-

Maximizing boiler output [3]

Colder boiler feed water will reduce the steaming rate of the boiler. The lower the feed water temperature, the more heat, and thus fuel needed to heat the water.

Boiler feed water quality

Condensate is distilled water, which contains almost no total dissolved solids (TDS). Boilers need to be blown down to reduce their concentration of dissolved solids in the boiler water. Returning more condensate to the feed tank reduces the need for blow down and thus reduces the energy lost from the boiler.

Summary of reasons for condensate recovery:

- Water charges are reduced.
- Effluent charges and possible cooling costs are reduced.
- Fuel costs are reduced.
- More steam can be produced from the boiler.
- Boiler blow down is reduced - less energy is lost from the boiler.
- Chemical treatment of raw make-up water is reduced.

Flash Steam Recovery

Flash steam is produced when condensate at a high pressure is released to a lower pressure and can be used for low pressure heating.

The higher the steam pressure and lower the flash steam pressure the greater the quantity of flash steam that can be generated. In many cases, flash steam from high pressure equipments is made use of directly on the low pressure equipments to reduce use of steam through pressure reducing valves.

The flash steam quantity can be calculated by the following formula with the help of a steam table:

$$\text{Flash steam available \%} = \frac{S_1 - S_2}{L_2}$$

Where: S_1 is the sensible heat of higher pressure condensate.

S_2 is the sensible heat of the steam at lower pressure (at which it has been flashed).

L_2 is the latent heat of flash steam (at lower pressure).

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