

Investigation of Method to Utilize the Waste Heat to Improve the Plant Performance in Sugar Industry

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Abstract:

In sugar factory, turbine exhaust steam is used to boil the juice. After boiling the juice exhaust steam loses its latent heat and changes its phase to water. It is called "condensate water". Now exhaust condensate from process house taken to the boiler feed water tank (storage tank) then by transfer pump it pumps to deaerator. After deaeration, through boiler feed pump, pumps to boiler. In this system at feed water tank there is a heavy heat and water loss through flash. But in modified system, the exhaust condensate from process house to direct deaerator, eliminating the feed water tank and transfer pump which saves water flashing, vapour loss and also saves energy of pump operation.

Keywords — Deaerator, Exhaust condensate, Feed water transfer pump, Boiler feed pump etc

1. INTRODUCTION

The direct exhaust condensate water injected to the deaerator tank by eliminating the feedwater tank. The water flashing at feed tank is eliminated and water temperature become 106-107 °C, actually at exhaust condensate tank water temperature 112°C. While travelling from process house (at exhaust condensate tank) to boiler it loses around 4-5°C temperature. So at deaerator water temperature is around 106-107°C. (Requirement is 105°C). By implementing the above new method by eliminating the feedwater water tank, feedwater transfer pump, by doing so,

- Increasing the water temperature in the deaerator to remove the non condensable gases.
- Steam conservation up to 2.057 TPH.
- Increasing in the additional crushing rate.
- Increasing in boiler performance.

- To eliminate the water flashing at feed tank.
- Vapour loss.
- To save the energy of pump operation by eliminating the feed water tank.
- To save the primary fuel this is feed to the furnace.

The main function of Deaerator is to remove the dissolved gases such as oxygen and carbon dioxide from feed water to prevent from corrosion in pipe, economizer, and boiler. Deaeration is achieved by steam which acts as scrubbing agent in deaerator and helps to vent the gases out to atmosphere. To remove gases from feed water, the temperature should be raised up to boiling point because solubility of gases depends on the temperature of water and partial pressure of the gas contact with it. When

the temperature of water is at boiling point for the pressure, the solubility of gases is zero.

1.1 Reason behind choosing Direct Exhaust Condensate Water into the Deaerator:

- Less time to complete the work than other method.
- Method is simple to design and construction.
- Does not involve much risk than other method.
- Economically better.
- Does not require much high skill persons.
- Does not disturb any other parts.

1.2 Reason behind not choosing Other Method:

Probable reason for not selecting the other method to increase the water temperature in deaerator was many modifications are required with other methods.

- Cost is high.
- Duration of time is more.
- Extra equipments are required with proper design with other parts.
- Difficulty to design and construction.
- Hence decided to direct exhaust condensate water into the deaerator by eliminating feedwater tank.

2. CALCULATION

a) Flashing vapour:

Before:

Temperature of exhaust condensate water = 112 °C

Temperature of feed water tank = 97 °C

Difference in temperature = 15 °C

Latent heat of steam at 112 °C = 530 kcal/kg

Quantity of water = 135 TPH (135000 kg/hr)

$$\text{Vapour loss} = \frac{135 (112-97)}{530} = 3.820 \text{ TPH}$$

After:

Temperature of deaerator water = 107 °C

$$\text{Vapour loss} = \frac{135 (112-107)}{530} = 1.273 \text{ TPH}$$

Saving the vapour flash = 2.546 TPH

Cost of RO water per litre = 2 paisa

Therefore, saving the make-up water up to 2546 liters per day and saving the cost of water price is 1222.08 Rs/day.

b) Fuel saving:

$$= \frac{100 (t-t_1)}{T+32-t_1}$$

Where,

t = Condensate feedwater/ deaerator temperature

t₁ = Temperature of feedwater/ deaerator before heating

T = Temperature of main steam

$$= \frac{100 (112-97)}{510+32-97}$$

$$= 3.37 \text{ TPH}$$

Before adopting method the fuel firing rate will be 60 TPH. So after adopting direct exhaust condensate method, fuel firing rate will be 56.63 TPH. Therefore fuel conservation up to 3.37 TPH. Its mean that generation of steam 132 TPH from the boiler by introducing the bagasse to the furnace is 56.63 TPH instead of 60TPH.

c) Boiler efficiency:

$$\eta_b = \frac{Q(H-h)}{q \times \text{GCV}}$$

Where,

Q = Steam flow rate in kJ/kg

H = Enthalpy of steam in kcal/kg

h = Enthalpy of feedwater temperature

GCV = Gross calorific value in kcal/kg

Before:

At 87 kg/cm² and 510⁰C enthalpy of steam (H) is,

WKT, 1 kg/cm² = 0.981 bar

At 85 bar & 510⁰C, H = 3392.8 kJ/kg

i.e. H = 810 kcal/kg (1kcal/kg = 4.187 kJ/kg)

Enthalpy of feed water temperature (h) = 105⁰C

Steam flow rate (Q) = 132 TPH

Fuel firing rate (q) = 60TPH

$$= \frac{132(810-105)}{60 \times 2250} = 70.5 \%$$

After:

Fuel firing rate (q) = 56.63 TPH

Enthalpy of feed water temperature (h) = 107⁰C

Therefore,

$$\eta_b = \frac{132(810-107)}{56.63 \times 2250} = 74.48 \%$$

Therefore, increase in boiler efficiency is 3.98 %

3. GRAPHS:

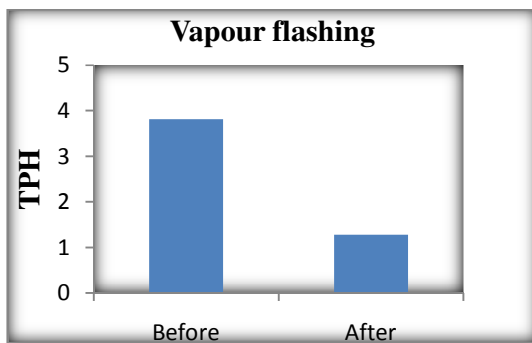


Fig.1. Vapour flashing

From the above fig. it can be observed that there is a decrease in the vapour loss from 3.820 TPH to 1.273TPH. Before adopting direct exhaust condensate method there is huge loss of water in the form of vapour in the feed water tank which is

reduce by implementing direct exhaust condensate method up to 2.546 TPH in this work.

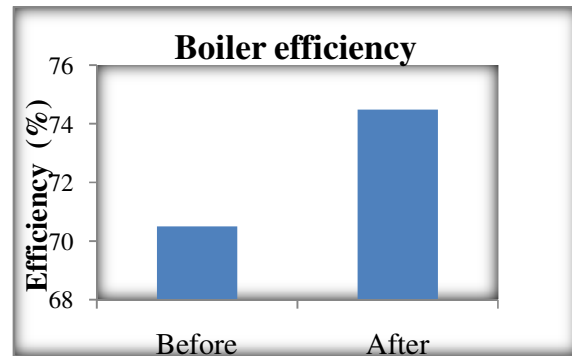


Fig.2. Boiler efficiency

The above fig. shows that increasing in boiler efficiency up to 3.98% after increasing the deaerator temperature from 105 to 107 °C by taking direct exhaust condensate water into the deaerator tank by eliminating the feedwater tank and feed transfer pump.

4. CONCLUSION

After adopting the above method the following improvements are observed.

- Injecting the exhaust condensate water to deaerator tank by eliminating the feedwater tank, the water flashing at feed tank is eliminated and achieve the water temperature about 106-107°C.
- Huge loss of water in the form of vapour in the feed water tank which is reduce by implementing direct exhaust condensate method up to 2.546 TPH in this work.
- Saving the exhaust steam 2.057 TPH.
- Fuel conservation up to 3.37 TPH.
- Boiler efficiency increases up to 3.98 %.

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