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Elimination of Feed water tank for Heat Recovery to Conserve the Fuel in Sugar Plant

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Abstract:

In present practice the fuel steam ratio is 1:2.2 so heat recovery is important in sugar industries to achieve the same amount of steam by feeding the less amount of fuel (bagasse) and it is possible by adopting the direct exhaust condensate method to deaerator tank by eliminating the feed water tank in sugar industries to avoid the vapour losses in feed water tank as a result good temperature of water is supplied to the boiler from deaerator tank that is above the boiling point temperature by doing so we can save the some amount fuel (bagasse).

Keywords — **Fuel (bagasse), Deaerator, High head pumps, Waste steam, motor etc.**

I. INTRODUCTION

Bagasse is the fibrous waste and by-product of the sugar industries, which is remains after crushing the sugar cane and it, is used as primary fuel in the boiler furnace to produce steam. The actual tendency is to use Bagasse as a primary fuel, especially for cogeneration plant to generate the power and steam, to increase the contribution of country's energy supply. Approximately 25-30% of Bagasse will obtained after crushing the raw cane. The Gross Calorific Value of dry Bagasse (ash free) is 19400 kJ/kg and Bagasse with 50% of moisture content has GCV about 9420 kJ/kg and Net Calorific Value (NCV) is about 7600 kJ/kg. GCV is also known as HHV (Higher Heat Value) and NCV is the LHV (Lower Heat Value).

(a) **Physical properties of bagasse:**

- White and light green
- Odorless
- Typical specific weight is 250 kg/m3
- Moisture content 50%
- Cellulose 45%
- Others 6%
- Energy content- 19400 kJ/kg

1.2 Chemical Properties:

Table-I
Chemical properties of bagasse

Components	C	H	O	N	S	Ash
% by wt (dry basis)	49	6.5	42.7	0.2	0.1	1.5

1.3 Composition and Combustion of Bagasse:

Table-II
Physical composition of cane

Sugar	10 to 16
Fibre	12 to 16
Water	65 to 80

Table -3: Physical Composition of Baggase

Contents	Percentage (%)
Fibre	45 to 53
Water as moisture	47 to 53
Sugar and Impurities (Bricks)	1.5 to 3

1.3.1 COMBUSTION OF BAGASSE:

Inlet to the furnace:

- Bagasse, which contains C, O_2, H_2, &H_2O as moisture
- Air for combustion contains O_2 & N_2

Outlet from furnace:

- $C + O_2 = CO_2$
- $2H_2 + O_2 = 2 H_2O$
- O_2, as excess O_2 from Bagasse or air
- N_2 from air

1.4 Gross/Higher Calorific Value (GCV/HCV):

Heat liberated by combustion of 1 Kg of Bagasse at 00C and 760 mm of Hg or 1.033 bar absolute pressure, and all the products of combustion are at same condition at 00C and 760 mm of Hg or 1.033 bar absolute pressure, i.e. vapours formed by combustion of H_2 and moisture in Bagasse are considers condensed.

1.5 Net/Lower Calorific Value (NCV/LCV):

The amount of heat liberated by 1Kg of Bagasse taken at 00C and 1.033 bar or 760 mm of Hg pressure, but water formed by H_2 combustion and as a moisture remains in the vapour form i.e. latent heat of evaporation is absorbed from released heat.

2. METHODOLOGY:

The following steps are carried out after modification the method,

a. To raise water temperature 105oc from 95-97oc to good deaeration as well as to increase boiler performance we need extra amount of steam.

b. To heat 135 tonne of water from 94oc to 105oc, the 3.857 t/h steam is required.

c. To save above 3.857 t/h exhaust steam which will help to full fill the process demand we adopted direct exhaust condensate water to deaerator tank, eliminating feed water tank.

d. To take exhaust condensate to deaerator, at deaerator spray nozzles this requires high head water to create spray as well as atomisation of water.

e. To create high head, high head pumps are installed for exhaust condensate water pump and higher specification pipe line to with stand of pressure 9 kg/cm2 is installed; earlier low head pumps and pipe lines are replaced.

f. At deaerator station, the high water temperature water is injected to deaerator through control valves which help to maintain the deaerator water level inside the deaerator tank.

g. By all above, the exhaust condensate water injected to deaerator tank by eliminating the feed water tank. By doing so, the water flashing at feed tank is eliminated and water temperature becomes 106-107˚C.

h. Actually at exhaust condensate tank water temperature 112oc. While travelling from process house (at exhaust condensate tank) to boiler it loses around 4-5oc temperature. So at deaerator water temperature is around 106-107oc. (requirement is 105oc).

i. By implementing above new method by eliminating the feed water tank, feed water transfer pump, and saving the exhaust steam 3.8 MT/hr as well as deaeration water temperature will be increased up to 106 to 107 oc.

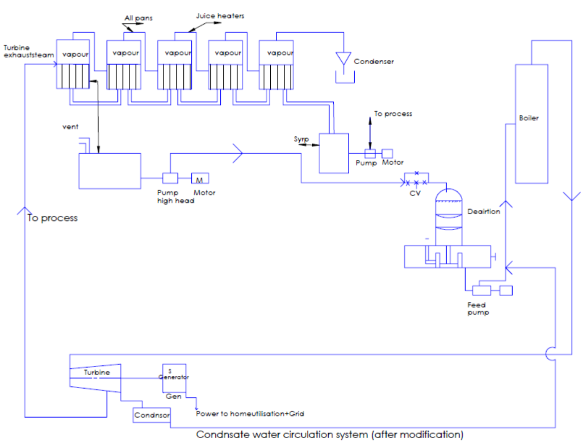


Fig 1. Condensate water circulation system

Additional equipment used:

Specifications:

Pump type – centrifugal water pump

Model – cpk-80/250

Head – 85 m

Capacity – 165 m3/h

Working temperature -120 oC

Speed – 2980 rpm

Pipe line used – carbon steel, sch 40

3. RESULTS AND DISCUSSIONS:

3.1 Before modification:

Table-4: Experiment readings

Time	Deaerator steam pressure Kg/cm2	Steam temperature OC	Water temperature OC	Steam consumption (TPH)
6am	0.2	130	104.9	1.99
7	0.3	140	106	2.27
8	0.35	135	105.5	2.14
9	0.3	132	105	2.01
10	0.25	135	105.5	2.14
11	0.21	134	104	1.76
12pm	0.23	136	105.5	2.14
13	0.25	137	105.8	2.22
14	0.25	133	105.2	2.06
15	0.25	135	105.5	2.14
16	0.22	134	104	1.76
17	0.23	136	105.5	2.14
18	0.28	135	105.5	2.14
19	0.29	134	104	1.76
20	0.26	133	105.2	2.06
21	0.24	136	106	2.27
22	0.25	135	105.5	2.14
23	0.26	135	105.5	2.14
24am	0.25	133	105	2.01
1	0.3	137	105.8	2.22
2	0.28	134	104	1.76
3	0.25	135	105.5	2.14
4	0.23	137	105.8	2.22
5	0.25	136	105.5	2.14

From above table we came to know that to rise the water temperature above the 1050C the steam requirement is about 2.05 TPH

Exhaust steam requirement:

= 135 (105-97) / 525

= 2.05 TPH

3.2 After modification:

Table-5: Experiment readings

Time	Deaerator steam pressure kg/cm2	Steam temperature oC	Water temperature oC	Steam consumption (TPH)
6am	0.3	140	108	-
7	0.28	136	107	-
8	0.25	135	107	-
9	0.232	134	106	-
10	0.212	130	105	-
11	0.22	132	105.5	-
12pm	0.22	132	105.5	-
13	0.25	135	106.5	-
14	0.3	140	107	-
15	0.22	132	105	-
16	0.225	134	105.5	-
17	0.25	135	106.5	-
18	0.25	135	106.5	-
19	0.25	135	106.5	-
20	0.28	136	107	-
21	0.232	134	105	-
22	0.232	134	105	-
23	0.25	135	106	-
24am	0.3	140	107.5	-
1	0.22	132	105	-
2	0.232	134	105.5	-
3	0.25	135	106	-
4	0.3	140	107.5	-
5	0.232	134	106	-

From above table we came to know that, without steam consumption there is a rise in water temperature above the 1050C and it is possible by taking the direct exhaust condensate water into the deaerator by eliminating the feed water tank.

4. CALCULATIONS & GRAPH:

Fuel saving = 100 (t-t1) / H+32- t1

Where,

t = Condensate feed water/ deaerator temperature

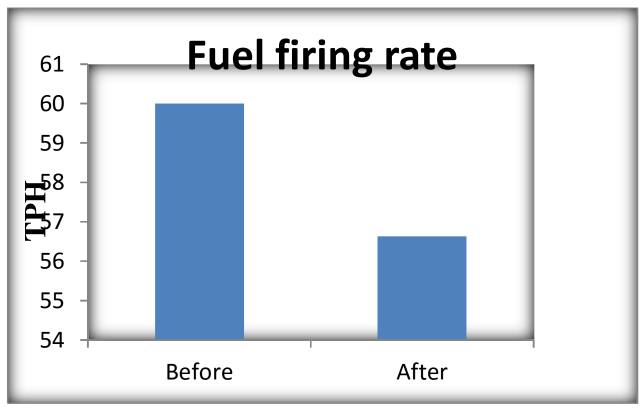
t1 = Temperature of feed water/ deaerator before heating

H = Temperature of main steam

= 100 (112-97) / 510+32- t1

= 3.37 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



Graph.1. Fuel firing rate

The above graph shows that conservation of fuel which is feed to the furnace up to 3.37 TPH. Before adopting the method the fuel burning rate will be 60 TPH for 132 TPH capacity of boiler (steam to cane ratio 1:2.2). After adopting the method the fuel firing rate will be 56.63 TPH. The saving fuel up to 3.37 TPH can be use for off season.

5. Conclusion:

By implementing above new method we are eliminating the feed water tank, feed water transfer pump, and saving the exhaust steam up to 2.05 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.

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