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BOILER EFFICIENCY INCREASED WITH THE HELP OF CONDENSATE WATER RECOVERY BY 4P PUMP

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ABSTRACT

Now a day's steam is becomes as our major utility. Our utility is the thing which is a basic need to make life comfort. Boilers are energy consuming thermodynamic devices which are used to produce steam or in other words we can say that boilers are pressure vessels designed to heat water or produce steam. In these days of energy conservation hot condensate is too valuable to be lost as it contains more than 25% of heat used in creating steam. Also it is distilled water making excellent feed water for boilers. These are pumps which are used to pump condensate to the desired location and are cheaper to operate as against electrically operated pumps which require special impellers to avoid risk of cavitations by condensate and temperature limits of condensate to be handled. The main objective of the proposed work is to increase the overall performance of the boiler during the steam generation. The condensate is collected in the receive tank bottom surface which is of high temperature. By using this condensate the performance of the steam generator is increased. The aims to achieve the following objectives Placed the pressure powered pump package unit (PPPPU).The proposed approach is concentrating towards the improvement of the steam generator performance By placing the PPPPU maintenance of the setup is becomes little bit complicated The aim of this work is to increase the efficiency of the steam generator i.e. boiler though which the overall performance of the plant is ultimately increased.

Keywords: Boiler, Pump, Condensate, Efficiency, Temperature, Performance, Pressure.

I. INTRODUCTION

Steam generating systems are sometimes become much costly to operate. Improved energy efficiency is the best way to mitigate rising prices, but it can be difficult to know where to start. Faced with steadily increasing energy bills, today's companies need to use a range of monitoring and targeting techniques to identify and implement energy saving measures. Energy conservation refers to reducing energy consumption through using less of an energy

service.Various criteria includingboiler size, type, burners and controls, and current level of efficiency wil l dictate what logical steps should be taken to improve energy efficiency. In general following order of priority applies for most boilers:

- Routine maintenance
- Efficiency-related maintenance

- Combustion efficiency
- Control systems
- Burners
- Fuel treatment
- Feed-water treatment

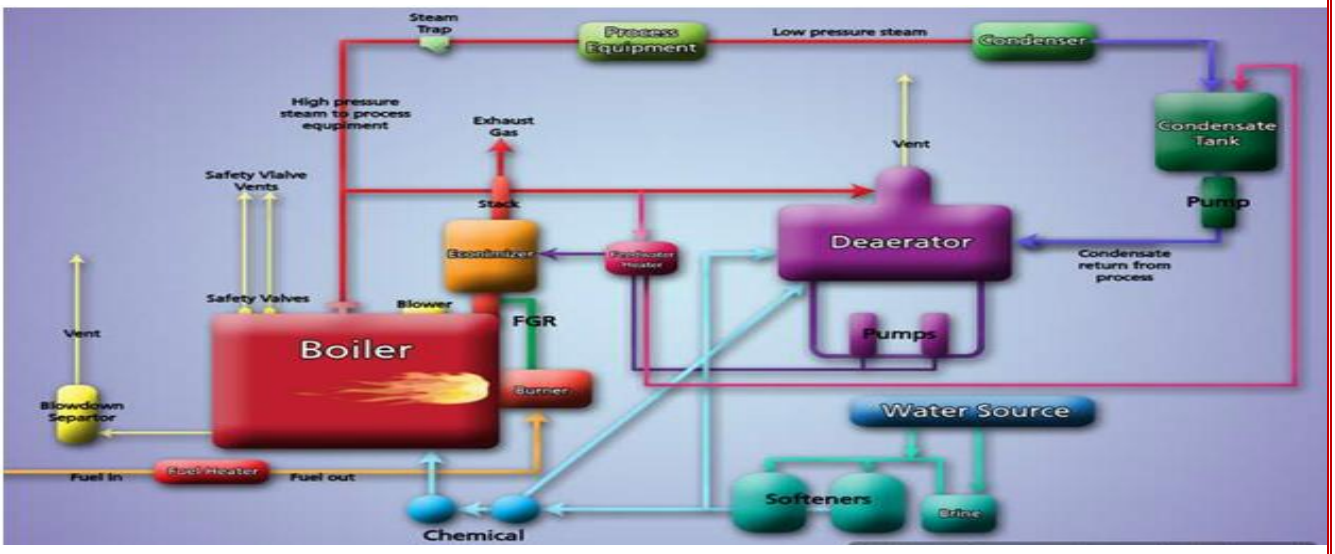

Fig.1. Typical steam generating system

Existing we are using fresh water for steam production in briquette boiler. Feed water temperature of fresh water is 30C in normal condition. Utilize steam has separate condensate water after phase changing whenever we has been used in heating operation. Condensate water temperature is near about 70 C. In case of pressure powered pump packaging unit steam condensate water has transferred from production block to feed water tank of boiler at high pressure with peak temperature. Briquette boiler efficiency increased with the help of condensate water recovery by pressure powered pump packaging unit After all these things steam used in very large span. The boiler or the steam generating systems are significantly consumes a large amount of energy and increase the operating cost of the rather than the other devices which is used in a plant or the place where steam generation is required. On the other hand we know that boiler or the steam generator are the fuel consuming devices in very big amount and it also requires very expensive maintenance with much labour charges so that ultimately the cost of the running of steam generator is very expensive. Hence there is need to make the running cost of the steam generator should be maintained as much as possible..

II. STEAM GENERATORS AND PRESSURE POWERED PUMP PACKAGE UNIT

Steam is one of the most important working substance in engineering works. The equipment necessary to produce steam are called Steam Generator or Boiler. In other words according to A.S.M.E Code a steam generating unit is defined as "A combination of apparatus for producing, furnishing or recovering heat together with the apparatus for transferring the heat so made available to water which could be heated and vaporized to

steam form". The main function of a boiler is to generate steam at a desired pressure and temperature by transferring heat produced by burning of fuel to water to change it to steam. The steam is used for following works:

- Power Generation and
- Processing

Power generation i.e. electrical power or mechanical work is obtained by expanding steam in steam engines or turbines. Boilers used in power plants are called power boilers. Steam utilized for industrial processing such as sizing, bleaching etc., in textile, chemicals, sugar and other industries. Boilers used in industries are called industrial boilers. Boilers are classified on the basis of following:

- Tube contents
- Method of firing
- Pressure of steam
- Method of circulation of water
- Nature of service
- Position and number of drums
- Gas passage
- Nature of draught
- Heat source
- Once through boiler
- Fluid used

Need and Definition of PPPPU: In these days of energy conservation hot condensate is too valuable to be lost as it contains more than 25% of heat used in creating steam. Also it is distilled water making excellent feed water for boilers. These are pumps which are used to pump condensate to the desired location and are cheaper to operate as against electrically operated pumps which require special impellers to avoid risk of cavitations by condensate and temperature limits of condensate to be handled.

Function of PPPPU: The Pressure powered pump package unit (PPPPU) is a skid mounted Assembly. The receiver collects the condensate through a unidirectional DCV the float assembly rises with the level of the condensate and at the predetermined level snaps a valve open to let in steam, while simultaneously a vent valve gets closed. The steam pushes the condensate out through the outlet DCV which too is unidirectional leading the condensate out to the desired point. Once the pumping is done the level of condensate falls and the float drops down automatically closing the steam valve and opening the vent to vent out the accumulated steam and allow the fresh condensate to enter and begin the next cycle. This is a maintenance free pump, functions as long as there is condensate coming to the pump. Provided as a complete skid mounted unit, with valves, strainers, DCV, condensate flow meter etc.

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Common Boiler Types

	CAST IRON	MEMBRANE WATERTUBE	ELECTRIC	FIREBOX	FIRETUBE	FLEXIBLE WATERTUBE	INDUSTRIAL WATERTUBE	VERTICAL FIRETUBE
Efficiency	Low	Medium	High	Medium	High	Medium	Medium	Low / Medium
Floor Space Required	Low	Very Low	Very Low	Medium	Medium / High	Low	High	Very Low
Maintenance	Medium / High	Medium	Medium / High	Low	Low	Medium	High	Low
Initial Cost	Medium	Low / Medium	High	Low	Medium / High	Low / Medium	High	Low
No. of Options Available	Low	Medium	Medium	Low / Medium	High	Medium	High	Low
Pressure Range	HW/LPS	HW / LPS HPS to 600 psig	HW / LPS HPS to 900 psig	HW / LPS	HW / LPS HPS to 350 psig	HW / LPS	High Temp HW, HPS to 900 psig	HW / LPS HPS to 150 psig
Typical Sizes	To 200 hp	To 250 hp	To 300 hp	To 300 hp	To 1500 hp	To 250 hp		To 100 hp
Typical Applications	Heating / Process	Heating / Process	Heating / Process	Heating	Heating / Process	Heating	Process	Heating / Process
Comments	Field Erectable					Field Erectable		

Note: HW = hot water' LPS = low pressure steam; HPS = high pressure steam
Source: "The Boiler Book" , Cleaver-Brooks

Table 1: Table showing classification of boiler

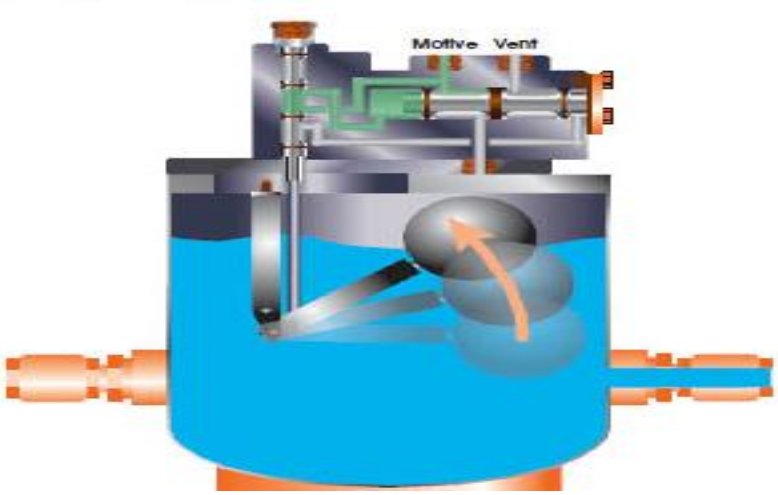

Fig.2 Diagram showing working of PPPPU

A PPPPU unit consists of following parts

1. A receiver
2. Inlet Isolation valve
3. Strainer
4. A body shell- containing a float mechanism which operates a set of motive steam / air inlet
5. Exhaust valves
6. Inlet & outlet disc check valves

The steam or air is used as motive media to operate the pump. Condensate comes into the pump receiver **from** flash vessel or plant condensate header and is allowed to flow in to the pump body having float mechanism by opening the inlet isolation valve In the normal position before startup the float is at the lowest position with the motive steam/air valve closed and the exhaust valve open. When condensate flows by gravity through inlet check valve in to pump body , the float will become buoyant and rise. As the float continues to rise, the mechanism link is engaged which increases tension in the springs. When the float **has** risen to its upper tripping position, the linkage mechanism snaps upward over center. The energy in the springs is released as the push rod is moved upward, to simultaneously open the motive steam inlet valve and close the exhaust valve. Steam flow through the inlet valve increases the pressure within the body and closes the inlet check valve. When the pressure in the body shell exceeds the backpressure in the condensate discharge line, it opens the outlet check valve and forces out the condensate in the discharge line. As the condensate level in the pump body falls, the float is lowered and mechanism link is engaged, which again increases the tension in the springs.

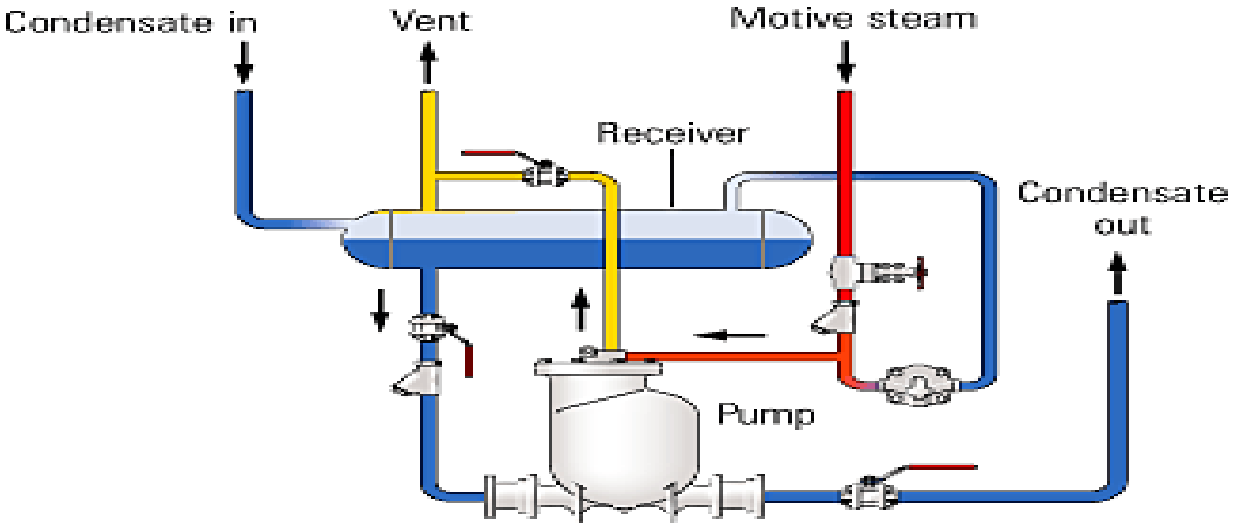

Fig. 3 working parts of pressure powered packaging unit

III. PROPOSED WORK

Existing we are using fresh water for steam production in boiler. Feed water temperature of fresh water is 30^0C in normal condition. Utilize steam has separate condensate water after phase changing whenever we has been used in heating operation .Condensate water temperature is near about 70 C. In case of pressure powered pump packaging unit steam condensate water has transferred from production block to feed water tank of boiler at high pressure with peak temperature. Pressure Powered Pump Packaged Unit is designed to pump condensate without electricity, using just 3 kg of steam per ton of condensate. The Pressure powered pump can pump condensate at higher temperatures and pressure. In 4-P Pump steam pressure applied to float valve and due to buoyancy effect water move to outside with higher pressure.

S.no.	Number	Description	Material
1	1	Cover	C.I.
2	2	Cover gasket	C.A.F
3	3	Stud and nut M-12	C.S.
4	4	Inlet valve seat	S.S.304
5	5	Inlet valve stem	S.S.304
6	6	Inlet valve head	S.S.
7	7	Inlet seat gasket	Cu
8	8	Exhaust seat	S.S.304
9	9A	Exhaust valve	S.S.304
10	9B	Exhaust valve head	S.S.
11	10	Exhaust valve gasket	Cu
12	11	Valve actuator disc	S.S.304
13	12	Push rod	S.S.304
14	13	Mechanism yoke	C.I.
15	14	Mechanism screws, M-12	S.S.304
16	15	Body	MS
17	16	Float	S.S.304
18	17	Linkage mechanism	S.S.304
19	18	Push rod actuator	S.S.304
20	19	Spring	S.S.

Table 2. Parts name and material of the part

Design condition of Pressure Powered Pump Package Unit:

PMA Maximum design pressure	8.7 bar
TMA Maximum design temperature	220°C
Operating inlet motive pressure Steam / Compressed Air /Pressurized gas	3 - 8.7 bar g (max)
Pump discharge per cycle	30 kg
Steam consumption	3 Kg of steam per 1000 Kg liquid pumped.
Air consumption	22 SCF per 1000 Kg

The working of the PPPPU is on the basis of steam air. The steam or air is used as motive media to operate the pump. Condensate comes into the pump receiver from flash vessel or plant condensate header and is allowed to flow in to the pump body having float mechanism by opening the inlet isolation valve in the normal position before startup the float is at the lowest position with the motive steam/air valve closed and the exhaust valve open. When condensate flows by gravity through inlet check valve in to pump body, the float will become buoyant and rise. As the float continues to rise, the mechanism link is engaged which increases tension in the springs. When the float has risen to its upper tripping position, the linkage mechanism snaps upward over center. The energy in the springs is released as the push rod is moved upward, to simultaneously open the

motive steam inlet valve and close the exhaust valve. Steam flow through the inlet valve increases the pressure within the body and closes the inlet check valve. When the pressure in the body shell exceeds the backpressure in the condensate discharge line, it opens the outlet check valve and forces out the condensate in the discharge line. As the condensate level in the pump body falls, the float is lowered and mechanism link is engaged, which again increases the tension in the springs.

IV. IMPLEMENTATION AND RESULT ANALYSIS

The pressure powered pump packaging unit which we discussed in previous chapter 4.An implementation has been made on boiler efficiency increased with the help of condensate water recovery by pressure powered pump packaging unit at the steam generator site in a plant. In this plant steam is producing by briquette boiler system. A briquette boiler is provided to ensure high operational efficiency and reliable performance.

In briquette fire tube boiler, the fuel is burnt inside a furnace. The hot gases produced in the furnace then passes through the fire tubes. The fire tubes are immersed in water inside the main vessel of the boiler. As the hot gases are passed through these tubes, the heat energy of the gasses is transferred to the water surrounds them. As a result steam is generated in the water and naturally comes up and is stored upon the water in the same vessel of fire tube boiler. This steam is then taken out from the steam outlet for utilizing for required purpose. The water is fed into the boiler through the feed water inlet.

V. OBSERVATION

Observing the periodical detection and maintenance according to the value displayed in the microcomputer control center, the operator can avoid the serious running default. The following detection content and method is a good guide for user.

5.1 Daily Running detection

1. Inspect the displayed content of the display screen.
2. If the compressor is in running status, the bearing oil pressure is required to be inspected. The oil level is required to be inspected, and the lubricant is required to be drained or added according to the demand.
3. Inspect the inlet and outlet water pressure and temperature of the condenser so as to compare with those in the design situation.
4. Inspect the leaving and entering temperature of the air compare with those in the design situation.
5. Inspect the condenser saturation temperature (confirmed according to the condenser pressure detected by the condenser sensor).
6. Inspect the discharge temperature of the compressor. The discharge temperature should be higher than 65 degree.
7. Check that whether the condenser pipe is fouling or blocking (the difference between the current condenser approach temperature and the one measured in the new chiller cannot exceed
8. Confirm whether the water has acceptable quality level.

9. Press Status key for displaying the alarming information once there is a display requirement.
10. Monitor the ambient air temperature.
11. Monitor the oil level.

5.2 Quarterly

Performing the chemical analysis of the lubricant each 6months (or perform the frequent inspection according to the requirement)

5.3 Biannually

1. Inspect and replace the cartridge of compressor oil filter.
2. Oil return system
    - Clean the oil filter
    - Inspect the operational situation of ejector for finding the impurity granule

Inspect the controller and safety protection device.

The unit should be located in an outdoor location where temperature ranges from 180 ~ 200 C with 6 Kg/cm2.

The units furnished with neoprene vibration isolator mounts for basement or ground level installations. Unit may by located on upper floor levels provided the floor is capable of supporting the total unit operating weight (in this application, the spring isolator is preferred).

A level floor, mounting pad or foundation must be provided by others, capable of supporting the operating weight of the unit.

SNO	**Physical Description**	**10 TPH**
1	Make	M/S IEAC
2	Boiler No	T/4914
3	Design Capacity	10TPH
4	Model	IXZ-FTB
5	Heating surface area Sqm	674
6	Working pressure (Bar)	15
7	Catering to Blocks	CTO-1 all blocks,FTO-1&CTO-3
8	Year of installation	2010
9	Fuel	Briquette
10	Type	External furnace
11	Type by water/fire	Fire tube
12	Briquette feeding to furnace	Manual
13	Ash removal	Manual

14	Dust Extraction system	NA
15	Connected Load in KW	97
16	Condition of the System	5

Table 3 Manufacturer Specification of the boiler

Measurement data with Briquette boiler before Pressure Powered Pump Package Unit installation Table below shows the performance of boiler. In this table we shown some following parameters such as steam fuel ratio and enthalpy of fresh water and steam with calorific value of fuel . These parameters are measured by digital tempearture & pressure guage respectively. Gross calorific value of fuel measured by adiabatic calorimeter.

Sn.	Total				Gross calorific value of fuel	Average steam pressure	Water enthalpy	Steam enthalpy	S/f ratio.	Boiler
	Feed water	Steam generation	Feed water temp	Total briquette consumption					Steam	Boiler efficiency
1	(KL)	MT	Deg C	(M.T)	(KCAL/KG)	(KG/CM2)	(KCAL/KG)	(KCAL/KG)	4.46	%
	122	117.8	35	26.408	4100	6.2	99.6	676.5		62.75

Table 4 Measurement data with Briquette boiler before Pressure Powered Pump Package Unit installation

Now for further we calculate the total loss of condensate water with checking by flow meter installation in all block user point. The data collected were as follows shown in tabular form. Table shown Measurement data with Briquette boiler for total loss of condensate water with checking by flow meter installation in all block user point

Sno	Total condensate water loss	Feed water	Total	
		(KL)	Condensate loss	
1	KL	122	KL	%
	48		48	41.42

Table 5 Measurement data with Bariqutte boiler for total loss of condensate water with checking by flow meter installation in all block user point

Measurement data with Briquette boiler after Pressure Powered Pump Package Unit installation Table below shows the performance of boiler. In this table we showed some following parameters such as steam fuel ratio

and enthalpy of fresh water and steam with calorific value of fuel. These parameters are measured by digital temperature & pressure gauge respectively. Gross calorific value of fuel measured by adiabatic calorimeter.

Sn.	Total				Gross calorific value of fuel	Average steam pressure	Water enthalpy	Steam enthalpy	S/F ratio.	Boiler
	Feed water	Steam generation	Feed water temp	Total briquette consumption					Steam	Boiler efficiency
1	(KL)	MT	Deg C	(M.T)	KCAL/KG	KG/CM2	KCAL/KG	KCAL/KG		%
	122	117.8	80	24	4100	6.2	99.6	702.4	4.83	64.53

Table 6 Measurement data with Briquette boiler after Pressure Powered Pump Package Unit installation.

Now for further we calculate the total loss of condensate water with checking by flow meter installation in all block user point. The data collected were as follows shown in tabular form. Table shown Measurement data with Bariqutte boiler for total loss of condensate water with checking by flow meter installation in all block user point. Total saving of water after installation of pressure powered pump packaging unit .

VI. CONCLUSIONS

The outcome of the whole work and studies made from the experimental data collected from the boiler are as follows

- Condensate water recovery approx 2% efficiency increase of boiler.
- Water consumption reduced 41.42 % after pressure powered pump packaging unit installation.

On the other hand there are some investments required for taking experimental data

So we have the installing coast of the pump

The Cost of 4-Pump = 20 Lakh rupees

For implementation of the whole work there are also some expenses like fabrication so that

Fabrication cost = 5 Lakh rupee

By the overall outcome we have

Total saving = 21000 Rs/day

The installing coast is returned within six months i.e.

Payback period = 6 Month.

REFERENCES

[1] Boiler Efficiency calculation report by super thermal power station.

[2] Chetan T. Patel "Efficiency With Different Gcv Of Coal And Efficiency Improvement Opportunity In Boiler" International Journal of Innovative Research in Science, Engineering and Technology (Volume 2, Issue 5, May 2013).

[3] "Energy Performance Assessment Of boiler ", Bureau Of Energy Efficiency.PP.1-22.

[4] J. Spisak, M. Cehlar, V. Jakao, Z. Jurkasova, M. Paskova. "Technical and Economical Aspects of the Optimization of the Steam Boiler". Acta Metallurgica. Vol 18. 2012.

[5] Kevin Carpenter, Chris Schmidt and Kelly Kissock. "Common Boiler Excess Air Tends and Strategies to Optimized Efficiency". ACEEE Sumer Study On Energy Efficiency In Buildings. 2008

[6] Raviprakash kurkiya, Sharad chaudhary "Energy Analysis of Thermal Power Plant" International Journal of Scientific and Engineering Research (Volume 3, Issue 7, July-2012)