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STUDY OF ENERGY CONSERVATION OF INDUSTRIAL BOILER AND STEAM SYSTEM

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Present investigation deals with the steam system used to provide process heat in pulp industries. Steam loss in the process, is a major problem faced by the industries. A well designed steam distribution system can reduce the losses and improve the efficiency of the steam system, thus reducing energy cost. Energy is one of the main factor which accounts for the cost in the pulp industry. Especially in times of high energy price volatility, improving energy-efficiency should be a primary concern for pulp industry. This paper provides information on the effective steam consumption and recovery technologies in the pulp industry. In order to provide guidelines for energy conservation, analysis is carried out on the Briquette-fired industry boiler and steam system. The huge amount of heat in form flash steam has been wasted, due to thermodynamics constrains. The flash steam generated contains up to half of the total energy of the condensate. After analysis the scheme is adopted as flash evaporation and chemistry disposal technology to recover the condensate water and used as a feed water for the boiler. The results indicate that there is increase in boiler efficiency from 63% to 78%. Fuel consumption reduction is observed from 5327 kg/day to 4457 kg/day.

Keywords: Fuel Consumption, Waste heat recovery system, Boiler Efficiency

INTRODUCTION

A large number of industrial processes are needed considerable quantities steam. Accompanying with the industrial process, low-temperature steam was used to discharging into circumstances directly without any recovery. Some essential measures should be taken to reclaim the steam in order to reduce the waste of energy and water. The pulp industry is the highest energy consumer (0.6%) in the India.

Consequently, efforts have been directed towards increasing the energy efficiency of the Pulp processes through implementing energy recovery systems. Any improvement of the energy efficiency of a chemical process must be based on a complete process site analysis involving the core process, and utilities production and distribution systems (Vandana, 2012). In this context, several aspects such as internal heat recovery, water system closure, energy upgrading

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and the power and energy generation are evaluated. The optimization of the power house typically considers aspects such as condensate recovery rate, boiler efficiency and cogeneration arrangements. However, the heat recovery from condensate is often ignored because of possible technical difficulties such as corrosion in heat exchangers (Mostajeran Goortani, 2012).

As steam losses its heat during the process, turns into water. Steam inevitably begins to do this as soon it leaves the boiler. This water is known as condensate and does not transmit heat effectively, reducing steam's heat transfer potential. When steam condenses by giving away its latent heat, the resulting condensate has same temperature. This heat termed as sensible heat and can be recovered. Heat in condensate is about 20% of the fuel energy burnt in the boiler. The condensate does not require demineralization, and can be returned directly to boiler feed water tank raises the feed water temperature, improving steam to fuel ratio. So, reclaiming condensate water appropriately made great effects on energy conservation and economy (Qun Chen, 2010). This cuts the fuel consumption thereby reducing the fuel bill. For every 6°C rise in feed water temperature saves 1% on the fuel bill (Madhav, 2013). Most of the proportion of the energy content in the steam is latent heat of evaporation. The latent heat of evaporation is actually utilized in the indirect heating process. The use of steam at lowest possible pressure for indirect heating reduces the steam requirements and fuel consumption. It is known that as steam pressure decreases in the saturation line, the latent heat of evaporation increases (Moran, 2002).

EXPERIMENTAL ANALYSIS AND METHODS

The plant chosen for this study was pulp industry. Figure 1 shows the process flow diagram of the plant. A plant has an extensive steam network. The fuel used was Briquette. Saturated steam was generated at 5 bar by using shellamax boiler. The saturated steam is supplied to process which used in four different sections i.e. syrup section, Clean In Process (CIP), can warmer and bottle washer. Calorific value of the briquette is 14644 KJ/kg. Purchase price of briquette was 5 Rs/kg. Stack temperature in the boiler was 140°C-160°C. The soft water was used as feed water input to the boiler. Blow down of the boiler was done manually in a day for 30 sec. Size of the blowdown valve is 50 NB (nominal bore size).

Figure 1: Process Flow Diagram of Plant
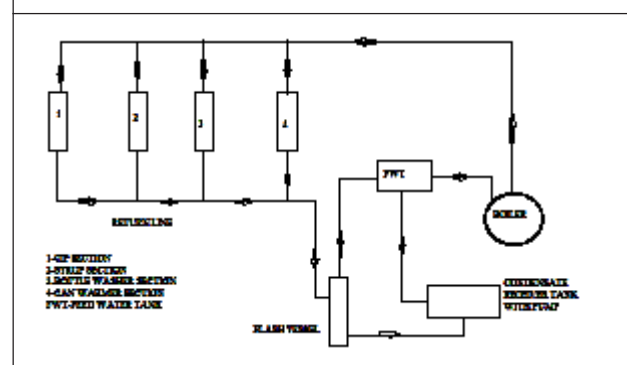
After the analysis, it is observed that all the condensate is not recovered from the Syrup Section and Can Warmer sections. The system is modified in such a way that, all the condensate water is recovered by closed steam-condensate recovery system. This condensate water is used as feed water for boiler.

CONDENSATE RECOVERY SYSTEM AND FLASH STEAM

Flash steam is a vapor or secondary steam

formed from hot condensate discharged into a lower pressure area. It is caused by excessive boiling of the condensate which contains more heat than it can hold at the lower pressure. Flash steam occupies more volume than water. If the pressure is increased, both the boiling point and the heat content increases. Conversely, if the pressure of the boiling water is reduced, the water is reduced, temperature of water as well as heat content reduces. It indicated that a certain amount of heat would be released, and this excess heat would be absorbed in the form of latent heat and water converted to flash steam.

$$\% \, Flash \ Steam = \left(\frac{SH - SL}{H} \right) \times 100 \quad ...(1)$$

where

SH = Sensible heat in the condensate at the higher pressure before discharge;

SL = Sensible heat in the condensate at the lower pressure to which discharge takes place;

H = Latent heat in the steam at the lower pressure to which the condensate has been discharged.

Condensate is returned from process heat exchangers at elevated temperature and therefore, it contains significant energy. Makeup water is replaced by the elevated temperature returned condensate, thus energy is saved. Conventional condensate recovery systems collect condensate from the steam system and feed it back into the boiler feed tank. But as the condensate leaves the steam system and enters the lower pressure environment of the recovery system. It causes up to half of the useful energy available in condensate vented as flash steam.

Figure 2: Flow Diagram of the System Analysis
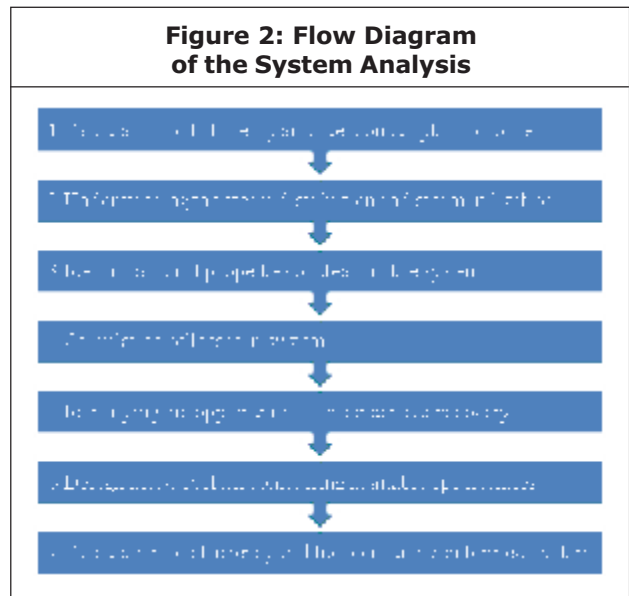
METHODOLOGY

The analysis of steam system has been done. The flow diagram of the steam system analysis.

First step of analysis was to calculate the efficiency and fuel consumption of industrial boiler (Figure 2). After this thermal analysis was done on the steam flow in order to calculate amount of steam produced, utilization of this steam in different sections of the plant. Properties of steam in the system were identified. The next step was to observe the points where losses takes place. Design a new system by considering opportunities for condensate recovery. Final step of analysis was to calculate the efficiency and fuel consumption of industrial boiler.

RESULTS AND DISCUSSION

In the present work, auditing is carried out on the whole process plant. During this analysis, it is observed that large amount of energy is wasted in the form of flash steam and condensate water. So, the techniques and technologies of heat recovery from condensate and flash steam are

analyzed. Waste heat utilization in the industry has vital importance.

In the recovery system, the hot condensate from Syrup section and Can warmer section is collected in a flash vessel, where flash steam is separated and fed directly to feed water tank and remaining condensate is collected in the tank. From condensate tank, it is fed to feed water tank by a pump. It is found that flash steam recovery system not only reduces economic losses from the plant, but it also reduces the steam flow in condensate return systems. The condensate flow out of the flash tank has much less flash steam. If the discharge is pumped and the pressure is maintained greater than the flash vessel pressure, no flash steam is produced in the condensate discharge piping. The experimental analysis conducted in the pulp industry, it shows that efficiency of boiler is improved and fuel consumption lower than the earlier.

i. Effect on Boiler Efficiency

Figure 3 shows graph of ratio of boiler efficiency for present design and design with heat recovery system. Heat recovery is used to reduce energy

Figure 3: Boiler Efficiency
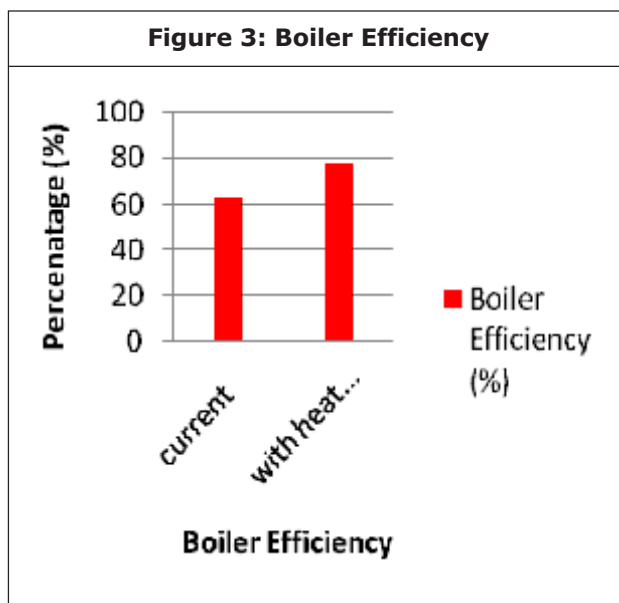
losses that result from boiler water blow down. Heat recovery equipment is used to recover and utilize the energy from the flash steam and condensate. Due to heat recovery system, it is observed that feed water temperature increases from $58^{\circ}C$ to $93^{\circ}C$. Boiler efficiency increases from 63% to 78% because increase in feed water temperature and reduction in fuel consumption.

ii. Effect on Fuel Consumption

Figure 4 shows graph of ratio of fuel consumption for present design and design with heat recovery system. From the audit conducted in pulp industry, it is observed that nearly 16% of total fuel consumption is wasted through flash evaporation and local condensate drainage. In terms of quantity of fuel 870 kg/day wasted through flash evaporation and local condensate drainage is saved which equivalent in rupees is nearly Rs. 17 lac per day. Due to heat recovery system, it is observed that fuel consumption reduces from 5327 kg/day to 4557 kg/day.

Figure 4: Fuel Consumption
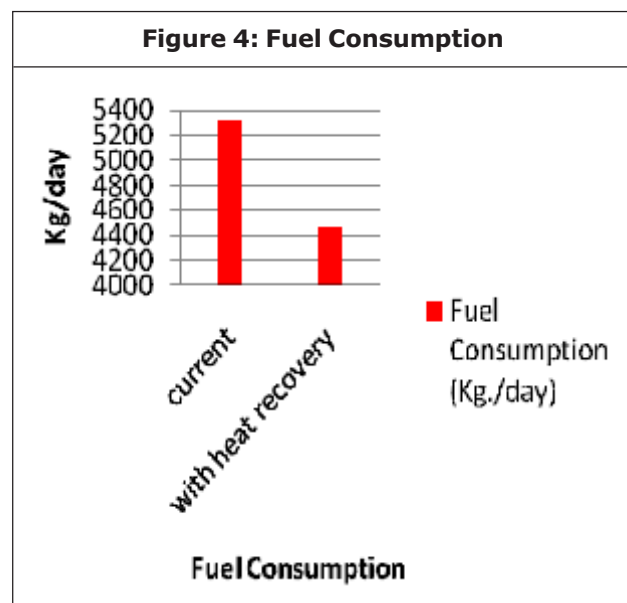
CONCLUSION

A process design considers energy and techno-economic constraints for recovering heat from

condensate. After experimental analysing, it is concluded that

1. Waste heat from the system is recovered and utilized.

2. Boiler efficiency is increased from 63% to 78% due to heat addition in makeup water.

3. Amount of fuel saved is 230,000 kg per year due to reduction in supply heat to makeup water.

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