Improving Condensate Removal and Collecting System

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This paper describes how the condensate return can be increased substantially, resulting a decrease in make up water requirement, boiler water treatment chemicals requirement, and an efficient operation of boiler house. The use of heat exchanger for utilization of its latent heat can be effectively made for condensate collection efficiency.

INTRODUCTION

Energy and water conservation have been topics of interest for almost all involved in any type of operation due to ever increasing costs of energy and fuel as well as water scarcity. As a tool for the same, system closure plays a vital role. For any operations involving indirect steaming, condensate is generated at elevated pressure and temperature. While in most industries, significant emphasis has been given to the utilization of flash steam generated for other operations; mills having single application of steam are forced to let the flash steam vent to atmosphere. This situation becomes more complex where, the mills have multiple boilers operating at different pressures, and the steam also is to be used for different applications, including direct and indirect steaming.

For the purpose of simplicity, the present work has been done in two parts. In first part, a single boiler system with a single consumption point has been considered, where all of the steam generated in a single boiler is being used only for drying of paper in MG cylinder. In second part, case of multiple boilers operation has been considered. Application of proposed system in case of a MF machine has also been described, where the steam is fed to different dryers.

Conventional System for Single Steam Consumption Point

In the conventional system, the condensate is taken through a steam trap to an open tank. To avoid any damage to the system in case of trap failure, a trap bypass line is also provided. In the mills, where, proper attention is not given to the efficient operation, it becomes a habit of some operators to let the bypass valve slightly open resulting in increased steam leakage. The condensate thus collected is pumped to boiler house with a pump. In this way, the losses take place due to-

1. Flashing, as heat is lost to atmosphere
2. Flashing, as condensate is lost to atmosphere
3. Pumping, as electrical energy is required.
4. Steam loss, due to opening of bypass valve.

Let us consider the case where steam is required only for drying purpose say at 3-4 bar pressure. Obviously, the condensate will leave the dryer section at temperature of the order of 130°C or so according to the boiling point of water at this pressure. When this condensate is released to atmosphere, a part of heat (and water also) is lost to atmosphere and as a result, less condensate is available to the boiler for reuse. The make up water, be it soft water, DM water, RO treated water, is very costly. The cost for water treatment could be as high as Rs.30-40 per Kl of water treated.

The problem does not end here. If soft water is being used, to maintain TDS level in boiler, frequent blow down is necessary, which again results in heat and water loss. It is not always feasible particularly for smaller boiler, to install on line TDS control system. During blow down, boiler water level goes down, due to which, extra feed water having relatively lower temperature has to be injected into boiler. This results in reduced pressure in the boiler, and hence the plant operation suffers.

Proposed System

For the systems, where the steam is used in pressure excess to 1 kg/cm^2, and the elevation of boiler feed water tank is not much higher than the condensate generating point; there lies a simple solution. In such cases, it is possible to discard steam trap, and the condensate is directed by the system pressure to boiler house. The pipe sizing is very important in such cases, but as a rule of thumb, a condensate line of 1/3rd of the steam feed line will be sufficient enough. A bigger diameter line may result in increased steam carryover along with condensate, while a smaller line less than of steam line, may result in improper condensate removal.

Steam Wastage from Proposed System

One may question the utility of proposed system that in absence of any steam trap, lot of steam will be wasted. It was tried to evaluate the quantity of maximum possible steam wastage by the proposed method. The following data are taken for a typical case:

Diameter of pipeline	20mm
Steam pressure inside MG	2.8 Kg/cm^2
Steam velocity in the pipeline	20 m/s (assumed)
Volumetric flow rate of steam	3.14 * 0.02 * 0.02 * 20 = 0.00628 m^3/sec= 22 m^3/hr
At 2.8 Kg/cm^2g, specific volume	0.49 m^3/Kg
Steam Flow Possible in the line	22/0.49 Kg/Hr. = 44 Kg/Hr.

If the normal steam consumption is of the order of 2200 Kg/hr, the maximum possible steam loss accounts for only 2%. while, on the other hand, we can easily save the power required to pump the condensate to boiler house. Furthermore, this results in increased feed water temperature and hence the requirement of oxygen scavengers is reduced.

To improve the system further, we may install a heat exchanger in the condensate pipeline. Now, the condensate heat is used to increase the temperature of makeup water. By reducing the condensate temperature, the flashing is reduced and hence condensate return is increased at least by 5-6%. For a mill having 80% condensate return, this yields in over 33% saving in water treatment costs.

In a typical case, a heat exchanger was installed and the hot water generated by this was used in other process. It was observed that the condensate return could be improved to 98%, from 78% earlier. These figures indicated that significant amount of steam was being blown to atmosphere through steam trap bypass valve. Alternatively, due to possible malfunctioning of steam traps, some amount of steam was being wasted earlier. The condensate transfer pump, which was of higher capacity earlier. failed at a number of times due to air/ vapour locking. This also resulted in overflow of condensate to drain and hence poor condensate collection.

The direct transportation of condensate not only reduced power consumption for pumping to zero, but resulted in a zero maintenance system. As the steam trap was removed, the life of rotary joint seals of the dryer increased by nearly 300%. Not only this, adoption of this system eliminated the use of steam traps, bypass

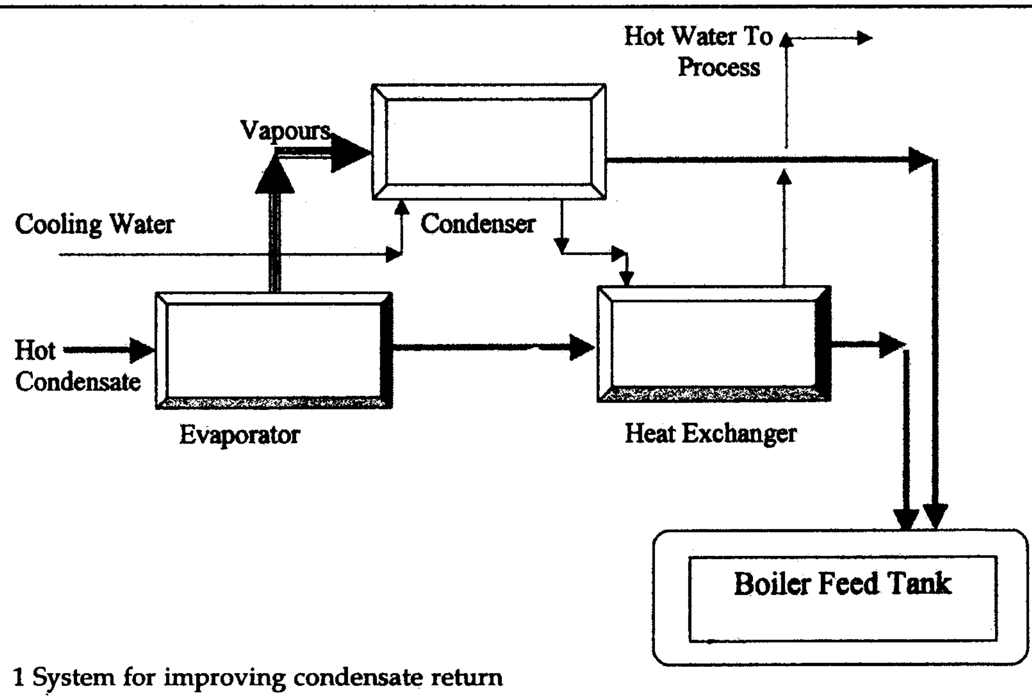

Fig. 1 System for improving condensate return

valves, etc. as all of condensate is removed from drying section very efficiently. With this, the boiler feed water temperature rose to 94-95 °C. thereby eliminating requirement of oxygen scavangers. As far as process is concerned, efficient condensate removal from MG resulted in better drying from MG and production could be increased.

A further improvement of the system is shown in the figure. Here, the sensible heat of the condensate is used to generate low-pressure steam in evaporators, which can further be condensed in condensers (Fig. 1). The process condensate being still higher temperature can be further cooled for reduced flashing. It has been found that this method can be used to have condensate recovery of upto and above 100%. Thus, we may even call the system as Zero Blow Down System.

Further Instrumentation Options

Many mills may like to add instrumentation to such systems. A logic has been developed for incorporation of the instrumentation for automatic control of condensate flow to the boiler house. The logic is as under-

1. A pressurized condensate tank is used to receive all condensate from dryer. This tank should be adequate enough to hold condensate for at least 5-7 minutes.

2. At the bottom of this tank, a pipeline is connected which transfers the condensate to boiler house. The pipeline is so sized that the condensate flow rate in the line is of the order of 2-3 m/s. This is done to ensure that all condensate with no or very less steam is sent to boiler house.

3. The above pipeline has a control valve, which controls the level in the tank via proper level control loop. If the level is high, the control valve opening increases, and vice versa.

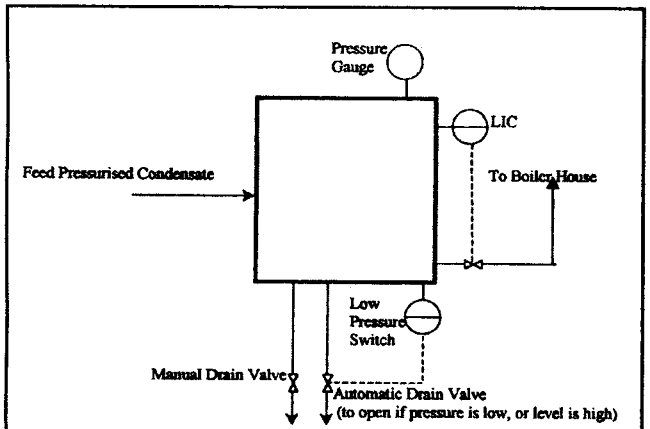

Fig. 2 Instrumentation schematic for direct condensate transfer

4. Another drain valve (solenoid valve) is fitted in the tank bottom that opens up if either the level is higher than alarm value or the pressure is below preset value, below which condensate cannot move to boiler house.

5. A manual drain valve is provided in the tank for draining this tank during emergency. Safety valve of course is not very much needed, as in this tank; pressure cannot be more than pressure inside drying unit or MG.

A schematic drawing has been shown in Fig.2 indicating the above instrumentation logic.

Advantages

This scheme has proved to be very successful on implementation, and in a particular case, the following results were achieved.

1. Increased boiler feedwater temperature from earlier 75-80 to 95 °C.

2. Annual boiler water treatment cost reduced to only 5% of cost earlier.

3. Condensate return increased from 78% earlier to over 98%.

4. No scaling on boiler tubes in two years of operation. Even after two years of operation, descaling was not at all required.

5. Blow down reduced from 10 times a day to once a day. Still, blow down TDS reduced from 3500 to <1000.

6. Reduction in boiler fuel due to reduced blowdown and increased feed water temperature.

7. As steam traps were eliminated, the possibility of air locking of traps, and hence poor condensate removal are avoided. This resulted in better heat transfer and hence increased production.

Multiple Steam Consumption Points

After successful implementation of the above scheme, it was observed that in case of dryers, where the condensate has to be taken from a number of points, separate condensate pipes were required to boiler house. In a particular case, in a calcium carbonate manufacturing unit having 7 rotary dryrers, it was tried to join the condensate piping to a header, and a single pipeline was used to transfer this condensate to boiler.

But, in a short while, all the dryers got filled up with condensate.

This created the need to develop a suitable system for condensate removal from dryers. For the same, a heat exchanger was designed, where the pressurised condensate was given in different tubes, and cooling water remained on the outside. There may be a requirement of several heat exchangers depending upon plant size, distance between dryers and piping requirement etc. The designed heat exchanger was of the shell and tube type. Only disadvantage with this was that the condensate could not be taken to the boiler house directly. A small ordinary monoblock pump was used to transfer this condensate to boiler. The hot water thus generated was used for washing operations within the plant.

This resulted in increased condensate return as well as generation of hot water free of cost for process requirements. It was also observed that due to efficient condensate removal from the dryer section, there was a sharp drop in drive load by approx. 20%.

In Fig. 3, such a typical heat exchanger is given.

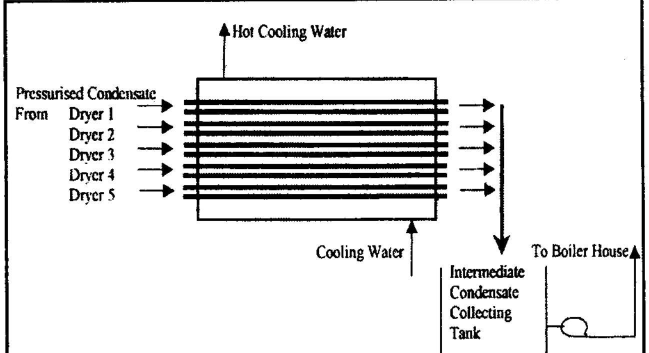

Fig. 3 Heat exchanger for condensate heat recovery for multiple dryers

Case of Multiple Boilers

There are many installations where more than one boiler has been installed, which operate at different pressures. The steam from lowpressure boiler is used for heating purpose, while the HP steam is used for power generation in turbines. In such a case, two boilers were installed, one of 15 TPH @ 32 Kg/Cm^2 working pressure, and the other was a 8 TPH @ 10.54 Kg/Cm^2 working pressure. HP steam was being used for power generation, and the condensate return was nearly 85%. LP steam was being generated at 8 Kg/Cm^2 pressure, and due to direct steaming in some applications, the condensate return was 55% only. The unit was interested to optimise the condensate system for maximum overall efficiency. No further improvement in condensate return was possible.

To begin with, it was decided to divert the condensate from LP boiler to HP boiler. As the feed to HP boiler became 100% condensate only, blow down was not required. For the sake of testing the blow down valve regularly, as well as for boiler water properties testing, one blow down was allowed to make every day. Simultaneously blow down from LP boiler increased, but this water due to being of lower temperature, heat losses were less.

It was observed that there were three to four breaks every shift. During a web break, steam to paper machine dryers is stopped, and hence boiler pressure increases. The boiler had two safety valves set at 9 Kg/Cm^2 and 9.5 Kg/Cm^2. On a web break, when steam supply is discontinued, pressure inside boiler increases and the safety valve bleeds. It was planned that on safety valve bleed, blow down is made. In this way, the bleed steam from safety valve, which was getting wasted earlier, is used to compensate the losses for blow down.

These steps ensured safe operating conditions for the HP boiler, which is more critical. The other boiler could be operated with increased blow down, and as the blow down is nearly continuous, a small blow heat recovery unit can be installed easily, for further improvement of energy efficiency.

CONCLUSION

We may improve the efficiency of condensate removal and collecting systems very easily. Some key actions in this area are use of static energy of condensate to transport it;

useing thermal energy (sensible heat) of condensate for process heating, and ensure the condensate temperature to be below atmospheric boiling point, and if possible, operate higher pressure boiler with cleaner feed water, i.e. maximum percentage of condensate.