

CONDENSATE AND ITS UTILIZATION

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STEAM AT WORK

Heat always from a higher temperature level to lower temperature level. Starting from the combustion temperature, heat flows thro the boiler tubes to the water. When the higher boiler pressure pushes the steam out of the boiler into the distribution system, the steam will be at a higher temperature than the surrounding air. Hence heat flows from the steam thro the walls of pipe to the air causing some steam to condense. When the steam reaches the heat exchanger where it is intended to heat some other medium, the steam returns to return to water form.

WHY CONDENSATE DRAINAGE IS NECESSARY?

- Hot steam in contact with condensate may produce water hammer, which is annoying and can shorten the life of the pipes, tubes and pipe fittings. It is essential to remove the condensate as heavy dew before it turns into dangerous slug.
- Condensate in heat transfer equipment takes up space and thus reducing heat transfer area. This reduces the performance of the heat exchanger. It must be promptly cleared from the system so that the heat exchanger is kept full of steam.
- Air is always present in inside the steam equipment during start up and comes into the system thro the feed water too. In addition the feed water may also contain carbonates that dissolve and release carbon di oxide gas. Air and carbon di oxide must also be removed from the system. Carbon di oxide forms carbonic acid with condensate and leads to corrosion. Air insulates the heat exchanger coils thus affecting the heat transfer process.

WHAT A TRAP MUST DO?

The trap must get the air, CO₂ and condensate out of the system as fast as they accumulate. In addition to the trap must also provide

- Minimum steam loss while removing the condensate, air and CO₂.
- Long life against wear.
- Working parts must withstand Corrosion due to condensate.
- Capable of venting air during start up too.
- Capable of venting CO₂ at the operating steam temperature.
- Must be able to operate against back pressure.
- Freedom from dirt and scale problems.

HOW TO ENSURE THE TRAP WORKS EFFECTIVELY?

- Make sure the trap is installed properly at the recommended orientation. It is often seen that the traps are installed in the wrong orientation.
- Install correct size of the trap. Many times lower size trap is installed without checking with the capacity charts of the manufacturer.
- Traps need periodical checking. In many installations it is noticed that there is no provision to check the trap functioning. Failed traps simply drain the steam from the heat exchanger thus leading to heat wastage. A recommended arrangement is shown in figure 1.

- Traps must be located close to the condensing system. Traps located away from the heat transfer equipment do not drain condensate effectively. They open only when the condensate is formed from the trapped steam in the piping, but not from the heat transfer equipment. See figure 2.
- Trap must be installed with suitable collection pots as otherwise the condensate may be pushed into the system itself instead of draining thro the trap. See figure 3.
- Do not provide common trap for two heat transfer equipment. This would lead to short-circuiting. This would lead to accumulation of condensate in the low-pressure heat transfer equipment. See figure 4
- Provide dirt traps / drain legs in layout to avoid nuisance to the functioning of the traps. See figure 5.

WHAT TO DO WITH CONDENSATE?

Condensate should be utilized in all possible ways as it contains large quantity of heat. A good concept is to generate flash steam and use further at low-pressure heat transfer equipment. At the end the condensate must be returned to the boiler house for mixing with feed water. This would give the plant an overall economy.

WHAT IS FLASH STEAM?

When hot condensate / boiler water is released to a lower pressure part of it is evaporated becoming what is termed as flash steam. For every pressure there is corresponding boiling temperature and the water contains fixed amount of heat. Higher the pressure higher the heat content. If the pressure is reduced, heat content is reduced and the water temperature falls to lower boiling temperature. This means certain amount of excess heat is available due to the difference in the heat content of water between the two pressures. This excess heat leads to evaporation of a portion of the water by adding necessary heat for boiling. This process is called flashing.

HOW TO ESTIMATE THE QUANTITY OF STEAM PRODUCED BY FLASHING?

Flash steam produced is calculated as per the following formula

$$\% \text{ Flash steam} = (H_{p1} - H_{p2}) / L_{p2}$$

Where,

H_{p1} - enthalpy / heat content of saturated water at operating pressure before the trap.

H_{p2} - enthalpy / heat content of saturate water at operating pressure after the trap.

L_{p2} - latent heat of evaporation at operating pressure after the trap.

WHERE CAN WE INSTALL FLASH VESSEL IN OUR PLANT?

1. In boilers where the feed water TDS is high, the boiler blow down will be also high in order the limit the boiler water TDS. In such cases the flash vessel can be installed to recover steam and preheat the feed water to the boiler.
2. In case of heat transfer equipment functioning at different pressures flash steam recovered from high pressure heat exchanger can be let into low pressure heat exchanger.
3. In case where direct injection of steam is used at low pressure the flash vessel steam can be used.

CASE STUDY

In a solvent extraction plant we were invited to modify their boiler for generating more steam as the steam was found to be inadequate for the process. It was found that the fuel consumption was such as

higher compared to the standard norms. We suspected the functioning of the traps. There was group trapping and closed trap drainage system in the plant. First the trap drainage system was modified to facilitate periodical checking and efficient condensate removal. We observed that there was good potential to generate flash steam and use in for direct steam injection points at bran preparatory section, toaster and CBDT vessel. We were also interested in avoiding condensate pump for pumping the condensate to the boiler house. Hence we choose to operate the flash vessel at pressure suitable for pumping the condensate. A sparger type Dip pipe system was also installed in the feed water tank to ensure that the condensate does not flash at feed water tank.