FLASH STEAM RECOVERY FROM SLOP BOILER BLOW DOWN

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ABSTRACT

Steam generators are widely used in industries for several purposes like power production, processing, heating etc.In industry steam generators are the major fuel consumers. In a normal steam generator about 4% of hot water is wasted as blow down. Due to this, a large amount of heat energy is wasted. This project aims to bring a heat recovery system to prevent heat losses, so that a large savings can be made. So in this a heat recovery system was designed to minimize the losses.

Keywords: *Boilers, Blow Down, Flash recovery*

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1. INTRODUCTION

In order to keep the limits and to remove any sludge, loose scales and corrosion products, a certain quantity of boilers is to be regularly drained. This process is called a Blow down. This is due to the fact that water inside the boiler gets continuously evaporated due to steam generation. Concentration of dissolve solid, inside the drum increases and reach beyond the limit, so carryover of solids along with steam can occur. To prevent boiler tube chocking and overheating of the boiler tubes the blow down is necessary. The quantity of water to be blow down will depend on the dissolved solids entering the boiler through the feed water. Thus parameters that are most often monitored to ensure this quality of steam are TDS and conductivity, pH, silicates and phosphates concentration. The boiler is blow down to reduce these levels and keep controlled to a point where the steam quality is not likely to be affected. A substantial amount of heat energy is lost in this process.

1.1. Boiler Blow down is necessary for two separate and distinct reasons:

1. To ensure that the concentration of total dissolved solids (TDS) is kept below a certain maximum allowable level.

2. To prevent the accumulation of **suspended solids** that collect at the bottom of the boiler drum.

II. TYPES OF BOILER BLOW DOWN

Boiler blow down should consequently be carried out in two distinct steps:

1. Continuous blow down
2. Intermediate blow down
2.1. CONTINUOUS BLOW DOWN: - Continuous blow down as the term implies, is the continuous removal of water from the boiler. It is just below the low water level for the purpose of control of Total Dissolved Solids of boiler

water. Continuous blow down lends itself ideally to recovery of some 80% of heat content and 10 - 20% (depending on boiler pressure) of pure water in the form of condensed flash steam. The exact location of the continuous blow down take-off line depends primarily on the water circulation pattern. Its position must ensure the removal of the most concentrated water. The line must also be located so that boiler feed water or chemical feed solution does not flow directly into it. The size of the lines and control valves depends on the quantity of blow down required.

Advantages: - **1.** The recovery of a large amount of its heat content through the use of blow down flashes tanks and heat exchangers. Control valve settings must be adjusted regularly to increase or decrease the blow down according to control test results and to maintain close control of boiler water concentrations at all times.

2. Maximum of dissolved solids may be removed with minimal loss of water and heat from the boiler.

2.2. INTERMEDIATE BLOW DOWN: - Intermediate blow down is designed to remove suspended solids, including any sludge formed in the boiler water. The manual blow down take-off is usually located in the bottom of the lowest boiler drum, where any sludge formed would tend to settle. Properly controlled intermittent manual blow down removes suspended solids, allowing satisfactory boiler operation. Most industrial boiler systems contain both a manual intermittent blow down and a continuous blow down system. Specialized valves are available to handle this arduous duty of handling hot boiler water containing solid particles, with reliable shut-off for long periods. In practice, the manual blow down valves is opened periodically in accordance with an operating schedule.

III. HEAT RECOVERY THROUGH BLOW DOWN

Heat recovery is used frequently to reduce energy losses that result from boiler water blow down. Installation of heat recovery equipment is valuable only when energy from the flash tank or the blow down water can be recovered and utilized. When an excess supply of exhaust or low-pressure steam is already available, there is little justification for installing heat recovery equipment.

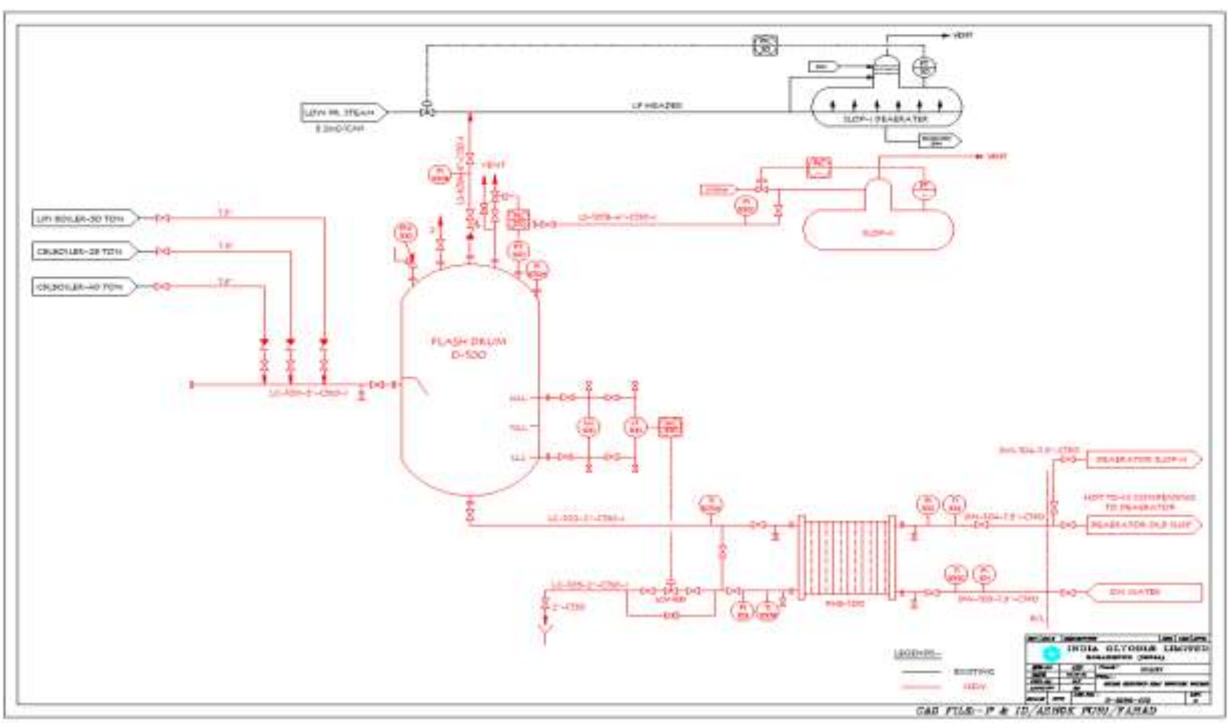

Fig.3.1.Heat recovery system(taken from India Glycols Limited, Gorakhpur)

In this system, boiler blow down water at the steam pressure and corresponding saturation temperature is discharged into a flash vessel where the pressure is reduced to a pressure near ambient pressure. This results in generation of flash steam that is taken to the deaerator where it is mixed with feed water. The remaining water at the lower pressure and temperature is passed through a heat exchanger where heat is transferred to treated make up water and raises its temperature. The preheated make up water is also taken to deaerator. The cooled blow down is then discharged to drain or used for additional purposes.

IV. CALCULATING THE BLOW DOWN RATE

$$\text{Blow down rate} = \frac{F \times q}{K - F} \quad \textbf{(4A)}$$

F	=	feed water TDS(ppm)
q	=	Steam generation rate(kg/h)
K	=	Require Boiler TDS(ppm)

The values are taken from India Glycols Limited, Gorakhpur (Boiler Unit – CBL1 & CBL2)

Feed water TDS	=	2 ppm		
Max. Allowable boiler TDS	=	120 ppm		
Max boiler capacity	=	75 TPH	(CBL1 – 30 TPH & CBL2 – 45 TPH)	
Steam generation rate(s)	=	68 TPH	(CBL1 – 28 TPH & CBL2 – 40 TPH)	
	=	68,000 kg/h		
Blow down rate	=	$\frac{(2 \times 68{,}000)}{(120-2)}$		
Total blow down	=	**1152.54 kg/h**		**(4B)**
	=	0.320 kg/s		**(4C)**
Blow down rate in (%)	=	just remove Steam rate in formula		
	=	[(2)/(100-2)] x100		
	=	0.0204		
	=	**2.04%**		

The amount of energy in each kg (h_f) at 42 bar = 1108 kJ/kg

h_f is the specific enthalpy of water at the saturation temperature –obtained from steam tables.

Rate of energy blown down	=	0.320 kg/s x 1108 kJ/kg
Rate of energy blown down	=	**354.56 kJ/s** (since 1kJ/s=1kw)
Rate of energy blown down	=	354.56 KW.

In below I will show how much of energy is saved from current running position of Boilers in India Glycols Limited, Gorakhpur. The energy available in flash tank and through heat exchangers is recovered by this process.

V. FLASH STEAM ENERGY RATE

The blow down water released from the boiler is water at the saturation temperature appropriate to the boiler pressure.

Blow down water is released to a flash steam system operating at 1 bar (from steam tables).

Specific enthalpy of water at 42 bar	=	1108 kJ / kg
Specific enthalpy of water at 1 bar	=	417.5 kJ / kg

This excess energy evaporates a proportion of the water to steam, and the steam is referred to as flash steam. The quantity of flash steam is readily determined by calculation.

$$\% \text{ Flash steam} = \frac{(h_f \text{ high pressure } - h_f \text{ low pressure})}{h_{fg} \text{ low pressure}} \times 100 \qquad \textbf{(5A)}$$

$$\% \text{ flash steam} = \frac{(1108-417.5) \times 100}{2305}$$

$$= 30\ \%$$

Therefore 30 % of the water blown down from the boiler will change to steam as its pressure drops from 42 to 1 bar g across the blow down valve.

Rate of flash steam = %flash steam x blow down rate
= (30/100) x **1152.54 kg/h**
= 345.76 Kg/hr.
= 0.096 Kg/s **(5B)**

Total energy per kg of steam = 2675.18 kJ/kg (hg at 1 bar)
Energy flow rate in flash steam = (rate of flash steam x hg at low pressure)
Energy flow rate in flash steam = 0.096 kg/s x 2646 kJ/kg.
Energy flow rate in flash steam **= 254 kJ/s**
= 254 KW. **(5C)**

VI. RECOVERING USING FLASH STEAM

The flash steam becomes available for recovery at the flash vessel. In essence, a flash vessel provides a space where the velocity is low enough to allow the hot water and flash steam to separate, and from there to be piped to different parts of the plant. The water temperature in the feed tank is important. If it is too low, chemicals will be required to de-oxygenate the water; if it is too high the feed pump may cavitate. Clearly, if heat recovery is likely to result in an excessive high feed tank temperature, it is not practical to discharge flash steam into the tank. Other solutions are possible, such as feed water heating on the pressure side of the feed pump, or heating the combustion air.

VII. ENERGY RATE USING HEAT EXCHANGERS

About 30 % of the energy in boiler blow down can be recovered through the use of a flash vessel and associated equipment; however, there is scope for further heat recovery from the residual blow down itself.

The total blow down = **1152.54** kg/h with **345.76** kg/h flashing to steam

Water flow rate through heat exchanger = 1152.54 – 345.76 = **806.78 kg/h** **(7A)**

Energy in water

Enthalpy(hf) at low pressure at 1 bar = 340.5 kJ/kg
Enthalpy(hf) at 30deg = 125.8 kJ/kg.
Energy available to heat the makeup water is = 340.5-125.8
Energy available to heat the makeup water = **214.7 kJ/k** **(7B)**

$$\text{Energy recovered} = \frac{\text{Water flow rate x heat make up water}}{3600}$$

$$= \frac{(806.78 \times 214.7)}{3600}$$

48.11 KW

Energy recovered from heat exchangers = 48.11 KW (7C)

VIII. TOTAL ENERGY SAVINGS

From the equations (5C) & (7C), we get

Energy from the flash vessel = 254 kJ/s
Energy from the heat exchanger = 48.11 kJ/s
Total energy recovered = 254 + 48.11 = 302.11 kJ/s

Total energy recovered = 302.11 kJ/s

The total energy recovered through flash tank and heat exchangers = 302.11 KW (1KJ/s=1KW).

This amount of energy is saved through blow down tank**.**

IX. LIMITING FACTORS AFFECTING BLOWDOWN

The blow down rate required for a particular boiler depends on the boiler design, the operating conditions, and the feed water contaminant levels. In many systems, the blow down rate is determined according to total dissolved solids. In other systems, alkalinity, silica, or suspended solids levels determine the required blow down rate.

There are many mechanical factors that can affect the blow down control limits, including boiler design, rating, water level, load characteristics, and type of fuel. Certain boilers may require lower than normal blow down levels due to unusual boiler design or operating criteria or an exceptionally pure feed water requirement. In some plants, boiler blow down limits are lower than necessary due to a conservative operating philosophy.

X.CONCLUSION

Blow down water carries thermal energy in the form of steam that can be reused may result in improve the boiler efficiency. Blow down heat recovery system may provide you with significant savings to the boiler plant i.e. from above study reveals total energy saved = 302.11 KJ/S.

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