SELECTION AND ANALYSIS PERFORMANCE OF STEAM TRAP IN PROCESS INDUSTRY

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Abstract

Steam trap is the most important link in the condensate loop because it connects steam usage with condensate return. The function of steam trap is to discharge condensate while not permitting the escape of live steam. For the efficient usage of steam inside the process equipment, the steam should be kept inside the device until the complete steam is transformed into condensate. For this to be happen the steam trap functioning will be in perfect condition. The main objective of the study is to analyse the operating characteristics of the presently installed steam trap and their effects on the efficiency of heat transfer in their respective process applications. From the study it may clear that trap failure may be of two-live steam to discharge and steam leak. Trap failure may also result in the water logging of heat exchangers of textile processing units. All these may results in excessive steam usage and it directly have an economy impact. This thesis work is an analytical study of steam traps to improve the steam system efficiency.

Keywords: Condensate return, Steam System, Steam Trap.

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1. INTRODUCTION

A steam trap is an automatic valve that allows condensate, air and other non-condensable gases to be discharged from the steam system while holding or trapping the steam in the system. When steam releases its heat energy in a heat exchanger making hot water, from a radiator heating a room, from a steam pipe transferring steam or from any process application, the steam reverts back to water. This water, technically referred to as condensate, must be separated from the steam and removed from the system or the system would back up with water[1]. The removal of condensate from steam is considered the primary function of the steam trap. If condensate is allowed to collect, it reduces the flow capacity of steam lines and the thermal capacity of heat transfer equipment. In addition, excess condensate can lead to "water hammer," with potentially destructive and dangerous results. Air that remains after system startup reduces steam pressure and temperature and may also reduce the thermal capacity of heat transfer equipment.

1.1 Types of Steam Traps

There are three basic types of steam trap into which all variations fall; all three are classified by International Standard ISO 6704:1982.

1.1.1 Thermodynamic Traps

Thermodynamic traps work on the difference in response to velocity change in flow of compressible and incompressible fluids. As steam enters, static pressure above the disk forces the disk against the valve seat. The static pressure over a large area overcomes the high inlet pressure of the steam. As the steam starts to condense, the pressure against the disk lessens and the trap opens to allow condensate out.

1.1.2 Mechanical Traps

Mechanical steam traps have a float that rises and falls in relation to condensate level and this usually has a mechanical linkage attached that opens and closes the valve[1]. Operate in direct relationship to condensate levels present in the body of the steam trap.

1.1.3 Temperature steam traps

Temperature steam trap have a valve that moves in/out of position by either expansion/contraction caused by temperature change. Some condensate builds up as it cools sufficiently to allow the valve to open. In most circumstances this is not desirable as condensate needs to be removed as soon as it is formed.

2. STEAM TRAP PERFORMANCE ASSESMENT

Steam trap performance assessment is basically concerned whether the steam trap is correctly working or not and analyzing its state of performance[2]. Sight, sound, and temperature measurements have been used to assess the performance of steam traps since steam traps were invented, but the measuring technology has evolved over the years. In particular, sound measurement has progressed to include ultrasonic devices that compare measured sounds with the expected sounds of working and nonworking traps to render a judgment on trap condition[3].
On part of this study, conducting a steam trap assessment in a textile processing unit at GIDC Sachin the following data's are obtained:

Name of Industry-Balaji Textiles Pvt Ltd
Location - GIDC Sachin, Surat
Type -Textile Dyeing & Printing

Table2.1 Steam Trap Assessment Report

Type of Trap	**Location**	**Selection**	**Status**
Thermodynamic(1")	Main header	Proper	Working
Thermodynamic(1")	Main line	Proper	Working
Ball float(1.5")	U-Jet Machine-1	Proper	Working
Ball float(1.5")	U-Jet Machine-2	Proper	Working
Ball float(1.5")	U-Jet Machine-3	Proper	Water Logged
Ball float(1.5")	U-Jet Machine-4	Proper	Working
Ball float(1.5")	U-Jet Machine-5	Proper	Working
Ball float(1.5")	U-Jet Machine-6	Proper	Working
Ball float(1.5")	U-Jet Machine-7	Proper	Water Logged
Ball float(1.5")	U-Jet Machine-8	Proper	Working
Thermodynamic (1")	U-Jet Machine-9	Improper	Rapid Cycle
Ball float(1.5")	U-Jet Machine-10	Proper	Not Working
Ball float(1.5")	U-Jet Machine-11	Proper	Leaking
Ball float(1.5")	U-Jet Machine-12	Proper	Leaking
Ball float(1.5")	U-Jet Machine-13	Proper	Working
Thermodynamic (1.5")	U-Jet Machine-14	Improper	Rapid Cycle
Ball float(1.5")	U-Jet Machine-15	Proper	Working
Thermodynamic(1")	Zero-Zero Machine	Proper	Leaking
Thermodynamic(1")	Main line	Proper	Working
Thermodynamic(1")	Zero-Zero Machine	Proper	Working
Thermodynamic(1")	Main line	Proper	Not Working
Ball float(1.5")	Loop	Proper	Working
Thermodynamic(1")	Main line	Proper	Working

From the visual observation of the steam system it is noticed that, the steam main lines and steam header are installed with thermodynamic kind of traps. In textile processing, u jet dyeing is the main steam consumption area[4]. Due to the large amount of condensate production, these are installed with ball float trap. But due to the cost wise economy of the thermodynamic trap compared to ball float one's, some jets are equipped with thermodynamic traps. This may cause rapid cycles in thermodynamic traps. It can be observed by sudden opening and shutting of disc in the trap by heavy sound. From the whole assessment of the Balaji Textiles, nearly 31% of the total traps is not functioning properly.

Total number of traps =23
Non functioning traps =9
Steam loss per trap =250kg/day
Total steam wastages =2250kg

ie, 2250kg of steam is wasted daily through non working traps, which equals a fuel amount of 242kg coal.

2.1 IMPACT OF IMPROPER TRAP SELECTION

From the analytical study conducted at Balaji textiles, found two traps are not properly sized and selected. These are traps which are installed at two thermodynamic traps installed in the jet dyeing machines. Jet machines are characterised by their high steam consumption. Due to this steam consumption the condensate flow rate is also very high. If TD traps are installed at these conditions, they can't be drain condensate properly and they are operate at rapid cycles, that means the disc in the trap open and shut at very faster rates even less than one second[5]. This condition of trap allows the release of steam along with the condensate, which results in the steam loss through drain.

Table2.2 Steam loss in Improper Trap location

Trap	Location	Required Steam Consumption(kg/day)	Present Steam Consumption(kg/day)	%Steam loss
Thermodynamic (1")	U-Jet Machine-6	7795	8105	3%
Thermodynamic (1.5")	U-Jet Machine-11	4412	4662	5%

In the present conditions, the jets with TD traps are characterised by rapid cycles hence they have higher steam requirements than its actual requirements. From the calculations its shown that it have a steam loss 3-5% which results in coal consumption of boiler.

2.2 IMPACT OF TRAP FAILURE

If steam traps do not remove water from steams system then droplets will be entrained in the steam. This entrained water can cause wear and tear on internal components of plant equipment, causing expensive repairs and possible placing plant personnel at risk[6]. When steam traps fail in the open or blow-by condition, they constantly pass steam. Steam traps are built with an internal orifice to limit the amount of steam loss, but it can still be significant. Because of the safety and process issues caused by failed steam traps, many operators choose to open the bypass of failed steam traps. While this reduces the safety and process impact of the failure, it increases the fuel consumed by the boiler and eats in to any excess capacity[7]. This has both a financial impact on your fuel bill and increases the impact on the environment from burning more fossil fuels.

Table2.3 Impact of improper selection

Trap	Location	Req.Temp.	Att.Temp.
Ball float(1.5")	U-Jet Machine-3	130	95
Ball float(1.5")	U-Jet Machine-7	130	90
Ball float(1.5")	U-Jet Machine-9	130	120
Ball float(1.5")	U-Jet Machine-10	130	115
Ball float(1.5")	U-Jet Machine-11	130	120
Ball float(1.5")	U-Jet Machine-12	130	118
Thermodynamic (1.5")	U-Jet Machine-14	130	116
Thermodynamic(1")	Main line	130	123
Thermodynamic(1")	Zero-Zero Machine	130	118

All temperatures are in ^{o}C

In textile processing units the main steam consuming area is heat exchanger in jet dyeing machine. In textile processing a temperature of 130^{o}C is to be achieved in a whole time of 60 minutes by steam through heat exchanger. But on analysis it is observed that , in some jets the process temperature is not achieved. This is due to the fact that when trap is water logged, it may leads to water logging in heat exchanger also. It will leads to cover most of the heat exchanger tubes with condensate and efficient heat transfer won't occur[8]. Hence the process temperature will not reach upto 130^{o}C. This will affect the dyeing quality of cloth.

3. GENERALISATION OF STUDY

As part of thesis similar trap assessment is performed in 11 more industries and their state of functionality is noted. From the study it is observed that nearly 15-27% of traps are not functioning well.

Table3.1 Trap Assesment

Industry	No. of Traps	Non-functioning
Amit Poly Prints Pvt Ltd	22	6
Anupam Dye & Prints Ltd	27	4
Rameshwar Textile Mills Pvt Ltd	24	8
Tejoday Dyeing & Printing Mills Pvt Ltd	32	3
BaidNarrow Fab Pvt ltd	33	6
Pushpanjali Dyeing & Printing Mills	28	6
Esspee Dyeing & Printing Pvt Ltd	32	8
Meenakshi Dyeing & Printing Ltd	22	4
Sneha Fashions Pvt Ltd	26	9
Armaan Industries Pvt Ltd	24	7
Adarsh Textiles Pvt Ltd	24	5

Analysing the traps in whole steam system, the state of functioning of each trap is found. This is performed mainly by analysing the variation in the sound of condensate flow through the orifice of trap. The ultrasonic leak detector which even detects the small variation in sounds and it gives a clear idea about its percentage of blockage to the operator.

Table3.2 Status of traps

Industry	25% Blocked	50% Blocked	100% Blocked
Amit Poly Prints Pvt Ltd	1	3	2
Anupam Dye & Printing Pvt Ltd	0	2	2
Rameshwar Textile Mills Pvt Ltd	2	4	2
Tejoday Dyeing & Printing Mills Pvt Ltd	0	0	3
BaidNarrow Fab Pvt ltd	0	2	4
Pushpanjali Dyeing & Printing Mills	1	3	2
Esspee Dyeing & Printing Pvt Ltd	2	2	4
Meenakshi Dyeing & Printing Ltd	1	1	2
Sneha Fashions Pvt Ltd	1	2	6
Armaan Industries Pvt Ltd	2	2	3
Adarsh Textiles Pvt Ltd	0	1	4

On analysing the state of functioning of traps, the steam loss through each non functioning trap is evaluated for a day. By this way, total steam loss through blocked traps in all industries were calculated as below.

Table3.3 Steam loss through Traps

Industry	Loss Through Trap(Kg/day)
Amit Poly Prints Pvt Ltd	1205
Anupam Dyeing & Printing Pvt Ltd	964
Rameshwar Textile Mills Pvt Ltd	1446
Tejoday Dyeing & Printing Mills Pvt Ltd	963
BaidNarrow Fab Pvt ltd	1606
Pushpanjali Dyeing & Printing Mills	1205
Esspee Dyeing & Printing Pvt Ltd	1766
Meenakshi Dyeing & Printing Ltd	883
Sneha Fashions Pvt Ltd	2328
Armaan Industries Pvt Ltd	1445
Adarsh Textiles Pvt Ltd	1445

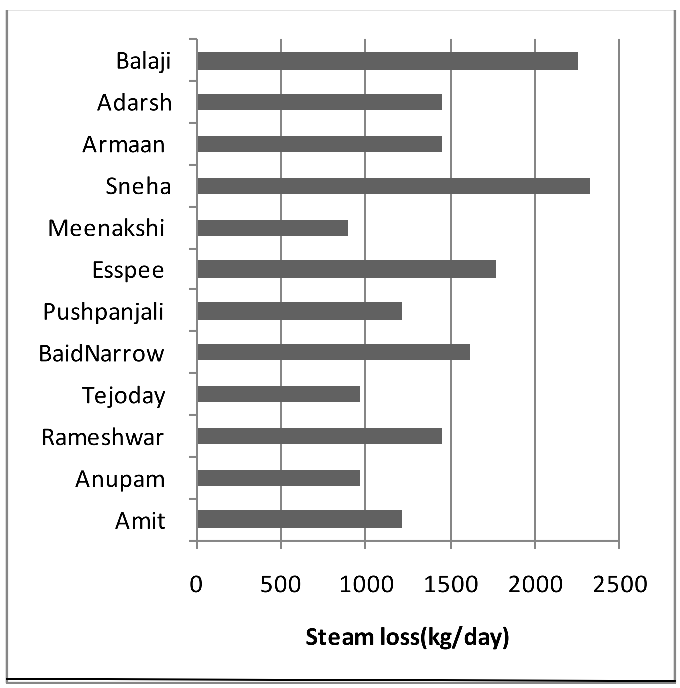

Figure3.1 Comparison of steam loss in various industries

5. CONCLUSION

From the analytical study conducted at Balaji Textiles Pvt Ltd, GIDC Sachin,Surat, the following results were obtained. An average of 2250kg of steam is wasted through the non working traps in the industry. Due to this improper selection of steam trap, the steam consumption for the respective processing machine is observed to be raised which causes a 3-5% steam loss. Steam loss directly coupled to the excess supply of fuel and which will increase steam production rate per kg of steam. Another problem of trap failure is that increase in the time to reach the process temperature. It will leads to a lower temperature in the processing machine in the process hold period.

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