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ANALYSIS OF STEAM TRAPS AT PROCESS PLANTS

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ABSTRACT

In most of the process industries, high pressure steam is utilized for many applications. The steam is produced in the boilers and carried through steam pipe lines to the process plants. During their travel through these pipelines, loss may occur due to loss of pressure, pipe line insulation failures and loss of temperature. These are known as losses in steam network. This reduces steam efficiency, thus the quality of steam becomes low at the receiving end. Steam Traps are automatic valves designed to trap steam and remove condensate from the steam lines. Thus a perfect steam trap can minimise steam loss and thus maximise the steam efficiency and quality. The project is focused at steam trap analysis and rectification in the industry through an exhaustive study of steam network. Based on the study, steam loss is calculated. Thus the investment and its payback period for the company is also calculated. Obviously, the longer an efficient trap lasts, the more it reduces energy wasted, fuel burned and pollutants released into the air. The benefits are energy savings and a cleaner, improved environment.

KEYWORDS : Steam, Steam Traps, Ultrasonic Leak Detector, Temperature Gun , Masoneilan Approach.

INTRODUCTION

Steam has been an accepted means of transmitting energy, since the industrial revolution. It is formed by the evaporation of water which is a relatively cheap and abundant commodity in the world. Its temperature can be tuned very precisely by the control of its pressure, using simple valves. It carries relatively huge amounts of energy in a small mass, and when it is encouraged to condense back to water, high rates of energy flow occurs, so that the heat using plant doesn't have to be very big. Steam is used for generating power and in process industries such as refineries, sugar, paper, fertilizer and textiles. Efficient transmission and consumption of steam is important, to maintain the required steam parameters at every utility point. This can be obtained by keeping the transmission and heat losses to a least value and recovery of heat, wherever possible. This is achieved mainly through steam traps, a device used to expel the condensate, thus maintaining the quality of steam at receiving end and retrieving the properties of condensate too. Thus the reliability and quality of steam trap plays a major role in ensuring quality steam and at the same time avoiding the steam loss. The prevention of steam loss counts to the energy conservation and hence to the monetary benefits of any organization. The following characteristics of steam make it so popular and useful to the industry:

- Highest specific heat and latent heat.
- Highest heat transfer coefficient.
- Easy to control and distribute.
- Cheap and inert.

MOTIVATION

Steam traps and steam systems represent a large portion of a manufacturing plant's total operating cost, but methods to reduce spending in this area are not clearly defined. Problems may arise when engineers lack knowledge regarding such questions as:

- How do steam traps affect the steam system and process and product quality?
- What are the best types of traps to use?
- What testing methods are used for determining trap failures?

The different considerations involved in selection, installation, and maintaining steam traps can make it difficult to recognize what is important and what is not. Typical information sources such as manufacturers and the site's previous experiences may not provide all of the necessary information. It can be helpful to break down cost reduction goals into smaller segments and analyze each separately. A common myth is that the purchase price of a new steam trap is a major component of system cost. Because the impact of operating cost is typically significantly higher than purchase price, it is important to understand the factors that negatively affect that cost. Total system operating cost is comprised of multiple components, including steam loss, generating cost and maintenance charges. Therefore steam trap failures can affect process operations and reduce profits. Choosing the right steam traps can improve reliability and reduce operation cost.

STEAM TRAPS

Functions of a steam trap

The job of the steam trap is to get condensate, air and CO2 out of the system as quickly as they accumulate. In addition, for overall efficiency and economy, the trap must also provide:

- Minimum steam loss.
- Long life and reliable service. Rapid wear of parts quickly brings a trap to the point of unreliability. An efficient trap saves money by minimizing trap testing, repair, cleaning, down time and associated losses.
- Corrosion resistance: Working trap parts should be corrosion-resistant in order to combat the damaging effects of acidic or oxygen-laden condensate.
- Air venting: Air can be present in steam at any time and especially on start-up. Air must be vented for efficient heat transfer and to prevent system binding.
- CO2 venting: Venting CO2 at steam temperature will prevent the formation of carbonic acid. Therefore, the steam trap must function at or near steam temperature since CO2 dissolves in condensate that has cooled below steam temperature.
- Operation against back pressure: Pressurized return lines can occur both by design and unintentionally. A steam trap should be able to operate against the actual back pressure in its return system.
- Freedom from dirt problems.

Types of steam traps

Depending on the different working principles, steam traps are classified into three.

- i. Thermostatic traps (based on the temperature difference between the steam and condensate).
- ii. Thermodynamic traps (based on the difference in velocity).
- iii. Mechanical traps (based on the difference in density).

Testing methods of steam traps

Steam traps are tested using temperature gun & an ultra sound leak detector. Temperature gun measures the temperature, both at the inlet and outlet of the trap while the ultra sonic leak detector detects the variation in sound in the steam line. The condensate if present in the line, produces sound and vibration. High pitched sound implies live steam leakage.

Applications of steam trap

Steam traps are used for steam distribution piping, heating, steam using equipments for trapping steam and removing condensate.

Steam loss estimation

Steam loss may occur due to the failure of traps or due to the leaks in the valves and flanges (module leaks) or else due to direct leaking of steam from the pipe line. Therefore steam loss is the sum of all the three losses in the steam network.

Steam loss due to trap failure is calculated by using Masoneilan formula for steam loss calculation.

$$L_{t,y} = (1\text{kg}/2.2046) FT_{t,y} * FS_{t,y} * CV_{t,y} * h_{t,y} * \sqrt{(P_{in,t} - P_{out,t}) * (P_{in,t} + P_{out,t})} \text{-----(1)}$$

Where,

- t: steam trap and y: is the period.
- L_{t,y} : Loss of steam (in kg)
- FT_{t,y} :failure type factor of ‘t’ during ‘y’.
- FS_{t,y} :service factor
- CV_{t,y} :flow coefficient.
- h_{t,y} :hours for which trap ‘t’ is operating.
- P_{in,t} :pressure of steam at inlet of trap
- P_{out,t} :outlet pressure of condensate at outlet of trap
- FS= 2.1*(s-1)/s , where ‘s’ is the capacity factor.
- CV=22.1*D² , where ‘D’ is the diameter of orifice of steam trap(meters).

Table 1. Failure type factor table for different trap conditions

Trap condition	FT
Rapid Cycling(RC)	0.2
Leaking(LK)	0.25
Blow Through(BT)	1

Table 2 . Service factor table for different applications

Application	FS
Process	0.9
Drip/tracer	1.4
Steam flow	2.1

Module leaks and direct leaks are calculated by the equation given below.

Discharge rate = 2.567 * e^{(1.845*(1-0.5))}, Where L is the plume length

FIELD DATA COLLECTION

Table 3 .Table for steam loss due to failed traps

Failed condition	D(m)	Pin(bar)	Application	Calculated steam loss(kg/hr)
RC	4.4	4.5	tracing	2.2
RC	4.4	4.5	tracing	2.2
RC	4.4	4.5	tracing	2.2
BT	4.4	4.5	tracing	11.0
RC	4.4	40	drain	19.6
LK	4.4	4.5	tracing	2.7
LK	4.4	4.5	tracing	2.7
LK	4.4	4.5	tracing	2.7

RC	4.4	40	drain	19.6
BT	4.4	18	drain	44

Table 4 .Table for steam loss due to module leaks

Trap no	Plume length(m)	Calculated steam loss(kg/hr)
1	0.5	2.6
2	0.2	1.5
3	0.1	1.2
4	0.3	1.8
5	0.2	1.5

Table 5 .Table for steam loss due to direct leaks

Trap no	Plume length(m)	Calculated steam loss(kg/hr)
1	0.3	1.8
2	0.1	1.2
3	0.3	1.8
4	1	6.5
5	0.3	1.8

Table 6 .Cost of steam (Rs/MT) in the process plant

Pressure(bar)	Cost(Rs/MT)
LP(4.5)	1867
MP(18)	2533
HP(40)	3093

RESULT

Total LP losses due to failed traps=25.7 Kg/hr
 Total MP losses due to failed traps=44 Kg/hr
 Total HP losses due to failed traps=39.2 Kg/hr
 Total steam loss due to failed traps=108.9 Kg/hr
 Total steam loss due to module leaks=8.6 Kg/hr
 Total steam loss due to direct leaks=13.1 Kg/hr
 Total steam loss in the process plant =130.6 Kg/hr
 Calculated monetary loss (Rs/annum):
 LP losses=25.67*1.867=47.98
 Rs/hr=4,20,304.8Rs/annum.
 MP losses=44*2.533=111.452
 Rs/hr=9,76,319.52Rs/annum.
 HP losses=39.2*3.093=121.245
 Rs/hr=10,62,106.2Rs/annum.
 Total monetary savings for the company=
 Monetary savings from (LP+MP+HP)
 =280.677Rs/hr=24,58,730.52 Rs/annum.
 Total investment required=installation cost + cost
 of each trap
 Cost of each trap= 2000Rs
 Installation cost=500Rs/trap
 Total number of failed traps=10
 Total investment required=(10*500)+2000

=7000Rs

Net saving=total savings-total investment
 =2458,730.52 Rs/annum. – 7000Rs
 =2451730.52 Rs/annum.

Savings/day=Total savings/365=6810.2Rs/day

Payback period=investment/savings
 =7000/6810.2
 =1 day


CONCLUSION

The savings by using steam trap is very high. Therefore periodic maintenance of steam traps is essential in all industries.

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