STEAM TRAP ANALYSIS AT PROCESS PLANTS

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Abstract - *In most of the process industries, high pressure steam is utilized for power generation. The steam is generated in the boilers and transported through pipe lines to the process plants. During their travel, loss may occur due to loss of pressure, insulation failure of the pipe lines and loss of temperature. These are known as steam network losses. This reduces steam efficiency and hence the quality of steam gets reduced at the receiving end. Steam Traps are automatic valves designed to remove condensate from steam lines and thus prevent steam loss by trapping the steam. Thus an efficient and suitable steam trap can reduce steam loss and hence increase the steam efficiency and quality. The project is aimed at analysis and rectification of steam traps in the industry through a detailed study of steam network. Based on the study, steam loss is calculated. More the efficient trap exists, the more is the energy preservation, less the expenditure of fuel and hence the pollutants discharge to atmosphere. The results are energy preservings and a taintless, flourished environment.*

Key Words: Masoneilan approach, steam traps, temperature gun, ultrasonic leak detector

1. INTRODUCTION

Since industrial revolution, Steam has been used as a prominent mode of energy transfer. It is produced by the evanescence of water, the relatively cheap and plentiful commodity in most parts of the world. Using valves, its temperature can be varied and fine tuned by the control of its pressure. It carries relatively large amounts of energy in a small mass, and when it is encouraged to condense back to water, high rates of energy flow are obtained, so that the heat using plant doesn't have to be unduly large. Steam is used for generating power and also used in process industries such as refineries, sugar, paper, fertilizer and textiles. In the process industries, the high pressure steam is generated in a boiler. It is distributed through a network for various process applications, after conditioning the steam to suit process requirements. Efficient transmission and utilization of steam is essential, for maintain the required steam parameters at every utility point, in the power and process industries. This can be achieved by keeping the transmission losses and heat losses to a minimum value and recovery of heat, wherever possible. The popularity and usefulness of steam to the industry is due to its following characteristics:

- .Uncostly and inert.
- High heat deportation coefficient.
- Simple control and shifting.
- High specific and latent heat

An energy conscious company is also an environmentally conscious company. Less energy consumed means less waste, fewer emission and clean and healthier environment. Bringing energy and environment together, lowers the operational cost of the company. Thus, it is essential that industry work towards energy saving and clean environment in steam system by properly designing condensate removal and recovery system. A steam trap is a device used to discharge condensate and non-condensable gases with negligible loss of live steam.

2. 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 finest 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 datas and science. It can be helpful to break down cost reduction goals into smaller divisions and pieces and analyze each separately. A common myth is that the procurement price of a new steam trap is a major component of system expenditure cost. Because the impact of running cost is exdtremely higher than procurement price, it is important to understand the factors that inversely 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.

3. FUNCTIONS OF STEAM TRAP

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

• Minimal steam loss

• Long life and dependable service. Rapid wear and tear 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 combatible to resist the damaging effects of acid or oxygen rich condensate.

• Air venting: Air can be present in steam at any time and especially on startup. Air must be vented for efficient heat transfer rate and thus combat system binding.

• Carbon dioxide venting: Venting carbon dioxide at steam temperature will prevent the formation of carbonic acid. Therefore, steam trap must function at or near steam temperature since carbon dioxide dissolves in condensate that has cooled below steam temperature.

• Operation against back pressure: Pressurized return lines can occur both by means of design and unintentional conditions. A steam trap shall be able to sail against the actual back pressure in its return system.

• Get rid from dirt problems.

4. BREEDS OF STEAM TRAPS

4.1 Thermostatic Traps

These traps sense the temperature difference of entering fluids. These are designed to unblock for cool fluid and block for torrid fluid. The pupose is - open for relatively cooler condensate or air, and close for torrid condensate. The blocking occurs when the fluid, particulalry hot condensate, has a temperature greater than or equal to a certain threshold value as per the design. The torrid temperature causes a thermostatic element to shift in such a manner that closes a valve head against a valve seat. This threshold value is less that of saturated steam, but the actual specific temperature to open/close varies depending on the category of thermostatic trap. Air, like condensate has a temperature considerably lower than steam, thermostatic traps are exceptionally good at venting large amounts of air.

4.2 Mechanical Traps

These traps sense the density difference of entering fluids. The design is such that it will allow more dense fluids and block the less dense fluids. The aim is to allow the discharge condensate, and block the steam. The property of buoyancy is utilized in selection of allowing mode and blocking mode of the traps, or more specifically valves. The buoyant object can be a sealed-round or oblong-float, inverted bucket or open top bucket depending upon the applications. The are two classifications of mechanical traps that operate on the density principle are Float and Bucket type.

4.3 Thermodynamic Traps

These traps sense the velocity difference of entering fluids and are designed to discharge condensate, a relatively slow-moving fluid, and close for flash steam, a relatively high velocity fluid. When condensate invades the trap body, it shifts slowly relative to steam and is freely expelled. When flash or live steam maneuvers across the underside of the disc, its speed is much higher than water, and this speed creates a pressure cutback which blocks the valve head. The valve stays blocked until the control chamber steam pressure above the valve head cutbacks, thereby allowing the valve to open.

5. TESTING METHODS OF STEAM TRAP

5.1 Visual Testing

Visual testing includes traps with open discharge, sight glasses, sight checks, test tees and three way test valves. In all the cases, the flow and variation of flow is ocularly observed. This method works hale with traps that cycle on/off, or dribbles on light load. On soaring flow or process, due to the volume of water and flash steam, this method becomes less feasable. If condensate can be diverted ahead of the trap or a secondary flow can be turned off, the load on the trap will drop to zero or a very minimal amount so the visual test will allow in determining the leakage.

5.2 Sound Testing

Sound testing includes ultrasonic leak detectors, mechanics stethoscopes, screwdriver or metal rod with a human ear against it. All these benefit the sound created by flow to determine the trap function like the visual method. This method works best with traps that cycle on/off or dribbles on light load. Traps which have attuning type discharge patterns are hard to check on soaring flow rate. Examples are processes, heat exchangers, air managing coils, etc). Again by diverting condensate flow ahead of the trap or shutting off a secondary flow as mentioned under visual testing, the noise level will ground to zero or a very low level if the trap is operating correctly. If the trap continues to flow at a soaring rate after diversion it would be chinking or blowing through.

5.3 Temperature Testing

Temperature testing includes infrared guns, surface pyrometers, temperature tapes, and temperature crayons. Typically they are used to gauge the discharge temperature on the outlet side of the trap. In the case of temperature tapes or crayon, they are set for a predetermined temperature and they indicate when temperature exceeds that level. Infrared guns and surface pyrometer can detect temperatures on both sides of the trap. Both the infrared and surface pyrometers require bare pipe and a clean surface to achieve a reasonable reading. The temperature reading will typically be lower than actual internal pipe temperature due to the fact that steel does have some heat flow resistance. Scale on the inside of the pipe can also affect the heat transfer. Some of the more expensive infrared guns can compensate for wall thickness and material differences. Blocked or turned off traps can easily be detected by infrared guns and surface pyrometers, as they will show low or cold temperatures. They could also pick up traps which may be undersized or backing up large amounts of condensate by detecting low temperature readings.

6. APPLIANCES OF STEAM TRAP

6.1 For Steam Distribution Piping

The role of steam distribution piping is to reliably supply steam of the highest reasonable quality to the steam-using equipment or tracing lines. One of the most important portrayal of steam traps on steam piping is to help block the crop up of water hammer. This is done by eclecting a trap that is designed to avert condensate from pooling.

6.2 For Steam-heated Equipment

Traps that continuously discharge condensate are typically recommended for these applications. Because the administration of steam-using process equipment and comfort heating equipment (like air heaters) is directly linked to productivity and product trait, it's important to select a trap that helps shorten start-up time and does not allow condensate to pool into the equipment, causing uneven heating, low heat transfer, and other similar problems. Air venting function is typically required in the trap to remove air and other non-condensable gases trapped in equipment and adjacent piping.

6.3 For Tracer Lines

Steam traps for tracer lines have different requirements because they are typically used with copper piping (because of its high thermal conductivity) to heat and maintain the fluidity of viscous fluids at temperatures below 100 °C (212 °F). A trap that has been fashioned to counter blockage from copper precipitate and that can efficiently use the sensible heat of steam/condensate is desired.

6.4 For Power-drive Equipment

Power-drive equipment includes all turbines used in compressor, pump, or generator applications, but may also include steam hammers or wheels. In each power-drive application, condensate should be eliminated rapidly for safe and effective operation, and should not accumulate inside the equipment to avert damage.

7. STEAM LOSS ESTIMATION

The loss of a steam trap is calculated by the equation given below which was derived from Masoneilan approach.

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

$P_{out,t}$:outlet pressure of condensate at outlet of trap in psia.

FS= 2.1*(s-1)/s , where 's' is the capacity factor.

$CV=22.1*D^2$, where 'D' is the diameter of orifice of steam trap in meters.

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

APPLICATION	S	FS
Process	1.75	0.9
Drip/Tracer	3.0	1.4
Steam flow	Very large	2.1

8. RESULTS

Table 1: Steam loss computation

Failure condition	Orifice dia	Pin(bar)	Appliance Of trap	Steam loss (kg/hr)
RC	4.4	4.5	Tracing	2.2
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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 2: Steam Cost/MT in the plant

LP(4.5bar)	1867
MP(18bar)	2533
HP(40bar)	3093

LP Steam Loss=25.7 kg/hr MP Steam Loss=44kg/hr HP Steam Loss=39.2kg/hr Total steam loss=108.9kg/hr

Monetary loss calculation (Lacs/annum): LP monetary loss=4.14 Lacs/annum. MP monetary loss=9.6 Lacs/annum.

HP monetary loss=10.4 Lacs/annum.

9. CONCLUSION

Steam traps serve the basic purpose of maintaining the aspect of steam at utilization end. At the same time it is necessary that these traps should be properly selected, designed and maintained so as to minimize the loss of steam in the steam network. Appropriate selection of traps as per the steam network parameters and routine maintenance of traps are necessary to mitigate the steam loss. Thus in addition to maintaining quality steam at utilization end, efficient trapping paves way for monetary saving and reduction in Green House Gas (GHG) emissions by saving steam & thereby reducing the fuel consumption.

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