International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 06 | June 2022 www.irjet.net p-ISSN: 2395-0072

Review paper on study and implementation of steam traps

Abhilash Koli[1], Prof. Dr. B. S. Gawali[2]

[1]M. Tech, Mechanical – Heat Power Engineering, Walchand College of Engineering, Sangli, Maharashtra, India
[2]Professor, Mechanical Engineering Department of, Walchand College of Engineering, Sangli, Maharashtra, India

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Abstract: High-pressure steam is used to generate electricity in most industrial industries. Steam is generated in boilers and transferred to the industrial facilities via pipelines. Loss can occur along their journey due to pressure loss, pipeline insulation failure, and temperature loss. Steam network losses are what they're called. This lowers steam efficiency and, as a result, lowers steam quality at the receiving end. Steam traps are automatic valves that catch steam and remove condensate from steam pipes, preventing steam loss. Because it is a steam connection utilization The steam trap is the most important link in the condensate loop when it comes to condensate return. The purpose of a steam trap is to allow condensate to escape while keeping live steam from escaping. The Thermodynamic Trap FMTD64 is full stainless steel with inbuilt strainer construction, and it is very best useful for header and mainline drains for steam systems. It is available with Flanged ends with Model having FMTD64 & with 25 Socket and also Weld Ends Model FMTD64SW.in this dissertation the applications of steam traps are studied and the set-up for testing of steam trap is made. The functional study of the steam test is done. The project is sponsored by The Forbes Marshall under the guidance of Mr. Mangesh Aashtekar.

Keywords: *steam trap, tests-up, Thermodynamic Trap, header, mainline drains.*

Introduction:

Wherever heating is required, steam has proven to be a flexible and versatile tool for the industry. Evaporation of water, which is a cheap and abundant commodity in most regions of the world, produces it. Its temperature may be precisely controlled by employing simple valves to alter its pressure. The dryness fraction, or the amount of fully dry steam present in the steam under consideration, is used to describe the quality of the steam. Steam cannot be described as dry saturated steam since it frequently carries microscopic droplets of water with it. Steam traps are used to keep the steam utilized for process or heating as dry as feasible. A steam trap is a valve that allows condensate and air to escape from a line or piece of equipment without releasing steam.

The three important functions of steam traps are:

- As soon as condensate is created, it should be discharged.
- No steam should be allowed to escape.
- The ability to discharge air and other non-condensable gases.

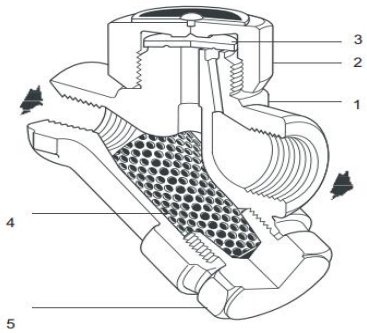


Fig. 1

Types of steam traps :

a) Mechanical traps:

Have a float that rises and falls in response to the amount of condensate in the system, and this is usually connected to a mechanical linkage that opens and closes the valve. The amount of condensate in the steam trap's body determines how effective mechanical traps are. Inverted buckets and float traps are examples of mechanical traps.

b) Temperature traps:

Thermostatic Steam Traps are controlled by the temperature difference between steam and condensate. The condensate's temperature is lower than that of the steam. A thermostatic steam trap has a port that opens or closes depending on the temperature of the intake fluid. The port is closed if the temperature exceeds the stated range. When the fluid temperature falls below the previously determined value, the port opens. Bi Thermostatic traps include liquid expansion and balance pressure traps, among others.

c) Thermodynamic (TD) traps :

are based on the dynamic response of compressible and incompressible fluids to changes in velocity. When steam enters, static pressure above the disc presses the disc against the valve seat. The static pressure over a large area overcomes the steam's high input pressure. As the steam condenses and the trap cycles, the pressure against the disc reduces. As a result, a TD trap functions as a "time cycle" device.

TESTING METHODS OF STEAM TRAP :

a) Visual Testing :

Visual inspection is a crucial initial step in establishing whether or not a trap is working effectively. Certain visible signals, If there is no condensate discharge or abnormally large amounts of steam oozing out of a trap, it may need to be repaired. External inspection of traps for pinhole, connection joint, and gasket leaks is also possible.

b) Sound Testing :

Most traps' opening and shutting valve mechanisms, as well as the condensate pouring through them, cause sound and vibration. When a trap isn't working properly, these sounds regularly vary (due to wear, blockage, or other factors). Recognizing this gap is one method of assessing the condition of a steam trap. Sound testing can be done with ultrasonic leak detectors, mechanical stethoscopes, screwdrivers, or a metal rod with a human ear against it.

c) Temperature Testing:

Among the equipment provided are infrared guns, surface pyrometers, temperature tapes, and temperature crayons. They're usually utilized to check the discharge temperature on the trap's outlet side. Low readings usually suggest an undersized trap, an improper trap pressure orifice, or a blocked trap/strainer discharge failure. Infrared guns and surface pyrometers may quickly detect blocked or turned-off traps since they will exhibit low or cold temperatures. They could also detect undersized traps or huge amounts of condensate backing up by sensing low-temperature readings.

Thermodynamic steam trap benefits include:

1) Thermodynamic traps can operate across their whole working range without requiring any tweaks or changes on the inside.

2) In comparison to the volume of condensate they may discharge, thermodynamic traps are small and compact.

3) Thermodynamic traps, which can be used on high-pressure and superheated steam, are unaffected by water hammers or vibration.

4) Thermodynamic traps are unaffected by freezing, and they are unlikely to freeze if placed vertically with the disc discharging freely to the atmosphere. However, functioning in this manner may result in the disc edge wearing off.

Material:

Table 1 material **[2]**

Sr. No.	Part	Material	Standard
1	Main Body	Stainless Steel	ASTM A 743 Gr.-CA 40
2	Cap	Stainless Steel	ASTM A 743 ,CA 40
3	Disc	Stainless Steel	ASTM A 743 ,CA 40
4	Strainer	Stainless Steel	Type 304 ASTM A 240
5	Strainer Cap	Stainless Steel	ASTM A 743 ,CA 40

Salient Features

1. With stainless steel, this design offers higher mechanical and corrosion-resistant qualities.

2. During the induction hardening process, the disc and seat were hardened to around 45RC, allowing them to endure continuous water pounding.

3. Seat becomes an extension of the body, eliminating leaky joints and gaskets.

4. Condensate enters concentric to the disc or seat below the disc, ensuring parallel and a clean reference to the seat with a lift to the disc, as well as eliminating any localized rip and wear.

5. An incorporated strainer filter with a sufficiently big area assures long and trouble-free operation.

The thermodynamic trap has the following advantages:

• Thermodynamic traps can be altered or tweaked without damaging the parts' internals.

• They are exceptionally compact, simple, and lightweight traps due to their large condensate capacity.

• Thermodynamic traps are unaffected by water hammers or vibration and can be utilised on high-pressure and superheated steam. The all-stainless steel design provides a high level of resistance to corrosive condensate.

• When fitted with the disc in a vertical plane and discharging freely to the atmosphere, thermodynamic traps are not damaged by freezing and are unlikely to freeze. However, this causes the disc edge to wear out in this position.

• The only moving portion is the disc, which may be removed without removing the trap.

There are a few disadvantages also,

• At very low differential pressures, the thermodynamic trap will not work because the flow velocity over the disc's underside is insufficient to allow for lower pressure. They are subjected to a minimum inlet pressure (usually 0.25 bar g) but can tolerate up to 80% of the inlet pressure in backpressure.

• Thermodynamic traps can release a significant amount of air on startup if the inlet pressure rises up slowly.' Air-bind occurs when a high-velocity cause builds up enough air to shut off the trap in the same manner that steam does. In addition, a separate air vent thermostatics was fitted in conjunction with the trap. In modern thermodynamic steam traps, an anti-air-binding disc can be employed to prevent air pressure from building up on top of the disc and allowing air to escape.

• The thermodynamic trap's emission can be loud, which may exclude its use in certain situations, such as outside a hospital ward or operating theatre. If this is a concern, a diffuser can readily be fitted to minimize discharge noise significantly.

• It's crucial not to oversize a thermodynamic trap, as this will cause cycle lengths to lengthen and wear. As long as the drain pockets are properly positioned, low-capacity variations are usually suitable for mains drainage applications.

Limiting conditions of FMTD64 :

Table 2 Limiting condition of trap 64 model [2]

Body design conditions	PN 63
Maximum allowable pressure	63 bar g @ 100 ^{0} c
Maximum allowable temperature	400^{0}c @ 42 bar g
Minimum allowable temperature	0^{0} c
Recommended maximum operating pressure for PMO	42 bar g
Minimum operating temperatures	0^{0} c
for satisfactory operations, a minimum operating differential pressure required	0.25 bar g
The maximum cold hydraulic test pressure of	95 bar g

Testing steam traps:

The following procedures can be used to verify a trap's operating state and whether it is functioning properly:

1. Visual inspection of traps is the first step in the testing process.

2. Using a temperature gun/equipment to test traps

3. Sound/ultrasound testing of traps

4. Online monitoring is used to test traps**.**

Working: The steam Trap FMTD64 is designed for header and mainline drains and is made of stainless steel with an incorporated strainer. It is available with Flanged ends and hence with Model FMTD64 & with this parameter in Socket Weld Model FMTD64

Testing of Forbes Marshall Thermodynamic Trap Testing Rig, (FMTD64)

• Failure detection is simple if a steam trap fails open and discharges into the open. If a steam trap fails to close or a steam trap from which condensate is collected fails to open, detection becomes more difficult. As a result, it's always a good idea to use the appropriate equipment to monitor the steam trap's operation on a regular basis. The following are the various problems that can occur when a steam trap fails to close.

• In this section, we discovered the failed steam traps, verified that there is no more steam wastage, and improved the productivity and performance of the steam system as well as testing parameters. It's also worth considering the consequences of steam trap failures in the steam system on the testing system's performance.

• Steam traps can fail in two ways: open or closed.

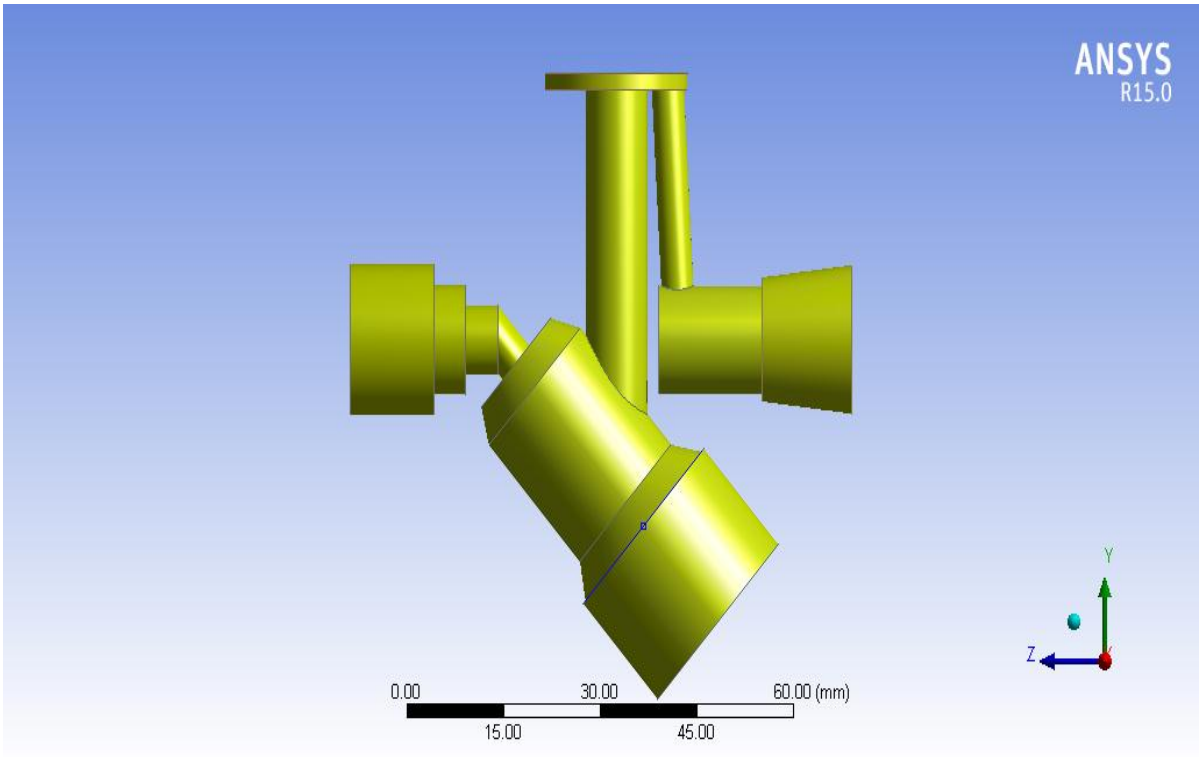
• When a steam trap fails open, it is referred to as an open valve since it leaks both condensate and steam. When a steam trap does not close properly, it behaves as a closed valve, preventing steam and condensate from passing through. Regardless of whether a steam trap fails open or closed, it does the same amount of damage to the steam system and should be fixed or replaced.

CFD ANALYSIS :

In this chapter, an analysis of steam trap as pressure distribution, and velocity variation is discussed.

Geometry :

Fig. 2 Steam trap geometry of fmtd64

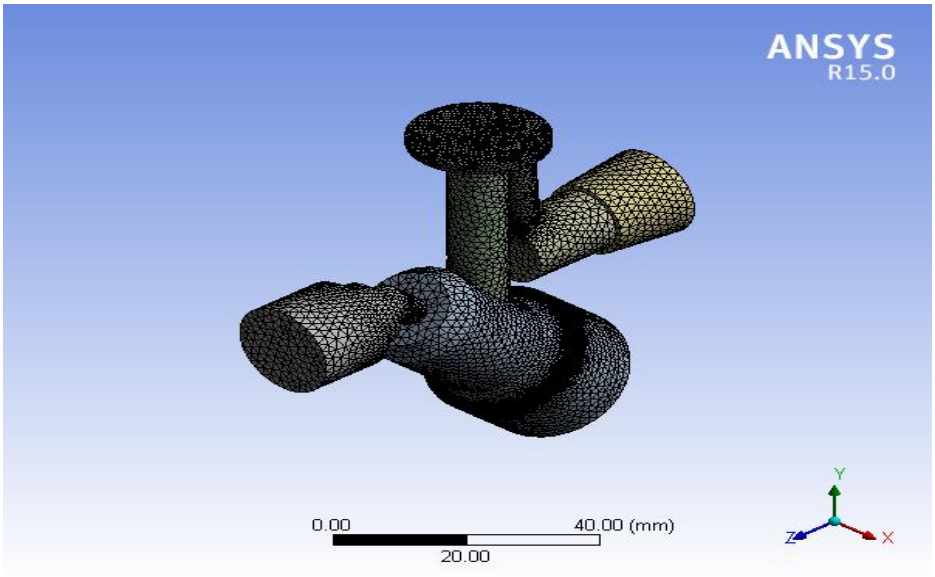


Meshing: the meshing of the model is done in the Ansys workbench.

1] Number of Nodes = 481393

2] Number of Elements = 243624

Fig. 3 Meshing



1] Cell zone conditions :

Table 3 Cell zone condition

Zone	Type
Inlet section	Fluid (vapor+ water)
Pressure section	Fluid (vapor + water)
Outlet section	Fluid
Porus section	Fluid

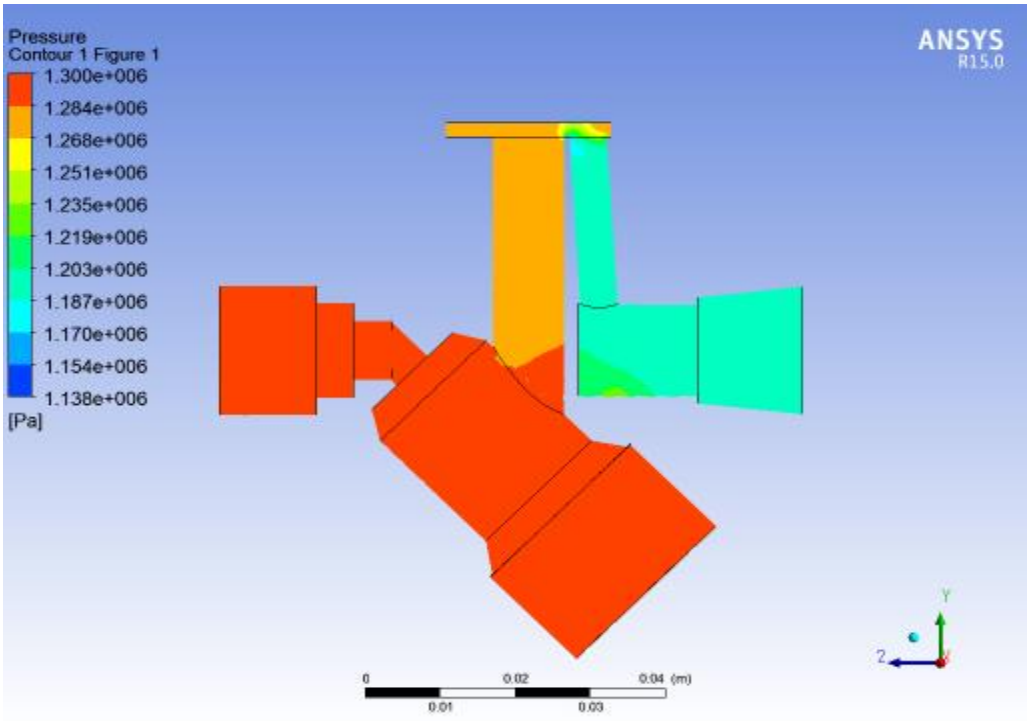
2] Boundary condition :

Table 4 Boundary condition

Zone	Type
Inlet	Pressure- Inlet
Outlet	Pressure- outlet
Porus section	Pressure

Pressure Distribution Figure :

Fig 4 Pressure distribution of trap 64 model



Results:

Experimental Result of steam trap test (64model) :

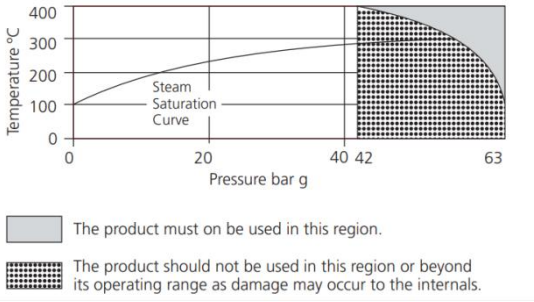
Table 5 Experimental readings

Sr. no.	TSP2 Header pressure in bar(tested)	Act. Time Taken (manually)	Settling Time
58878	12.96	91	60
58879	13.07	61	60
58880	13.03	65	60
58881	12.98	69	60

Operating Range of Product:

The product was used in the range of not more than 40 to 42 pressure bar g at a temperature of 400^0c range used for without damaging the product.

Fig. 5 operating condition from Forbes Marshall manual



Operating pressure range of this product:

- Maximum operating pressure PMO = 14.0 bar g @ at 197^0 c
- Maximum operating temperature TMO = 400^0 c @ 5.5bar g
- Hydraulic test pressure in the cold = 21.0 bar g (ANSI #150)
- PMO (Potential Operating Pressure) = 41.5 bar g 253^0 c
- TMO (Temperature Maximum Operating) = 400^0 c at 28.0 bar g
- test pressure of hydraulic = 62.0 bar g

Conclusion:

- It is concluded from the above study and data, that study and testing of thermodynamic steam trap can be done manually.
- The steam traps are checked under the limiting conditions and within the operating conditions.
- The pressure parameter of CFD analysis is also the experimental result. At 12.84 bar.

Future Scope:

If the results of manual testing are acceptable, automatic testing also can be implemented.

Similar products can be tested by the same method.

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