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Steam Traps

Introduction

The power of steam was first demonstrated in the 1st century AD in Alexandria on a device called Aeolipile, also known as a Hero's engine. The first practical use of steam power dates from 1698 and the invention of the steam driven pump. Beginning in the industrial revolution in the 18th century, steam became commonly used in driving equipment such as locomotives and pumps. In the 20th century the use of steam as motive source began declining, changing its primary use to a heating source.

When used as heating source, steam changes its state to condensate, which needs to be drained from the system for continued efficient operation. Initially steam condensate had to be remove manually by operating valves. Steam traps were subsequently developed to act as an automatic valve to remove condensate.

Types of Steam Traps

There are many types of steam traps, and selecting the appropriate type will depend on the specific application, such as steam power-driven equipment, steam-heated equipment, tracer lines and process equipment. The most common types of steam traps include:

- **Mechanical Traps:** These traps have a float that rises and drops inside the trap following the level of condensate. A linkage opens and closes the valve depending on the position of the float. These traps are categorized as **i**nverted buckets and float traps. The float traps are also classified as free ball float and lever ball float. See Figure 1.

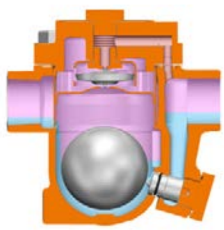

Figure 1 Free Float Trap

- **Temperature Traps:** These traps have a valve operated by means of thermal expansion or contraction. Considerations should be made when selecting this type of traps whether quick condensate removal is needed, as cool temperatures are required to open the valve. Temperature Control, Thermostatic and bimetallic are some examples of this trap type.
- **Impulse Type:** These traps operate on the principle that hot water under pressure will flash into steam when the pressure is reduced. A circular baffle keeps the entering steam and condensate from striking a cylinder or disk. Under normal condensate load, the valve opens and closes at frequent intervals. This discharges a small amount of condensate at each opening. With a heavy condensate load, the valve remains open and allows a heavy, continuous discharge of condensate. See Figure 2.

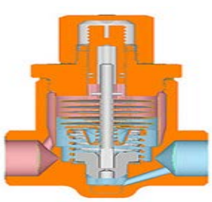

Figure 2 Impulse Trap

- **Thermodynamics Traps**: These traps respond to velocity change in the flow of compressible and incompressible fluids, which means that the valve will open even if there is only steam present, possibly causing quicker wear, even locked up trap condition.
  See Figure 3.
- Venturi Nozzle Traps: Without having failing mechanical components, steam and condensate pass through multiple stages, where the denser liquid (condensate) continuously throttles the venturi nozzle, which keeps the steam from escaping. The drawback is that it requires that the steam and the condensate are free of particles and corrosion deposits. See Figure 4.

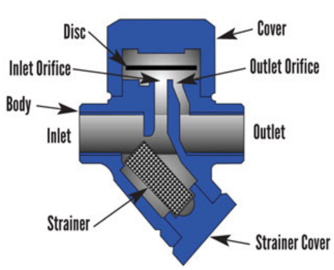

Figure 3 Thermodynamic Trap

Steam Trap Performance Assessment

Three primary methods are used to verify the performance characteristics of steam traps: visual, sound and temperature. The visual method requires the ability to distinguish flash steam and live steam through skilled observation practices. The sound method requires the ability to differentiate the correct or abnormal sound to assess the efficient function of the traps. The temperature method requires the installation of a continuous temperature measurement system capable to reading temperatures at the inlet and outlet ends of the trap and be able to generate a trending report over a specific period of time.

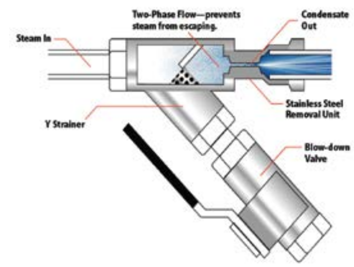

Figure 4 Venturi Nozzle Trap

Maintenance

A good steam trap preventive maintenance plan is required to prevent loss of BTU power throughout the steam distribution lines. The Industrial Controls Company (see reference below) indicates that an approximately annual failure rate of steam traps of 5% is possible. Having a good maintenance program can reduce trap failures. Some of the most notable trap malfunctions are:

- Water hammer in steam and condensate lines
- Condensate receiver is venting steam
- Condensate pump water seal failed prematurely
- Overheating or under heating in conditioned space
- The vacuum in the return lines becoming difficult to maintain
- Presence of steam in condensate return lines
- Almost equal trap inlet and outlet lines temperature
- At a plant level, boiler operating pressures are difficult to maintain, causing abnormally higher energy bills

Regularly assessing steam trap performance can provide a basis for preventative maintenance. There are several systems that can be used to accurately maintain the steam traps and to stay ahead of the potential failures including ultrasonic trap testers which can improve the steam trap monitoring plan which can detect a leaking trap. Visual testing can be assisted by thermal infrared camera imaging that can detect more accurately the differential temperature between the inlet and outlet ends of the traps. The most accurate device that has been developed is the integral thermocouple that consists of a sensor located inside a chamber in the strainer cavity and it is capable of determining, by conductivity, the physical state of the medium (steam or condensate) with undeniable results.

Reference for Further Reading

1. Trap Installation Orientation, TVL, A Steam Specialist Company
   https://www.tlv.com/global/TI/steam-theory/trap-installation-orientation.html
2. Steam Trap Testing, Proficient Technologies,
   http://proficienttechnologies.com/steam-trap-testing/
3. Testing and Maintenance of Steam Traps, Spirax/Sarco, Steam Engineering Tutorials
   http://www.spiraxsarco.com/Resources/Pages/Steam-Engineering-Tutorials/steam-traps-and-steam-trapping/testing-and-maintenance-of-steam-traps.aspx
4. Steam Trap Maintenance, Industrial Controls, an Eriks Company,
   https://www.industrialcontrolsonline.com/training/online/steam-trap-maintenance