Proposed Tech Sheet #ST109

Key Considerations for Steam Trap Selection and Sizing

Similar to other steam system equipment, proper selection and sizing of steam traps is essential to efficient, reliable, and safe system operation. These critical devices are necessary in steam systems to hold steam in the system until it condenses to allow for heat transfer, while relieving the system of condensate and, in many cases, air (and other non-condensable gases).

FCI defines a steam trap as an integral, self-actuated valve which automatically drains condensate and vents air and other non-condensable gases from a steam-containing enclosure while providing tight shut-off of live steam.

An undersized or improperly installed steam trap can prevent proper drainage of condensate from the steam system, potentially leading to inefficient heating, erosion, and dangerous water hammer. An oversized steam trap can result in steam leaking into the condensate-return system, potentially leading to elevated return-line pressures, erratic temperature control, and increased energy costs.

Steam traps are classified based on their principles of operation. FCI 87-1, Classification and Operating Principles of Steam Traps, provides detailed information on the types of steam traps. This tech sheet provides guidelines to be considered for proper selection and sizing of a steam trap in various applications to ensure an efficient, reliable, and safe system.

Selection and Sizing Considerations in Drip Applications

Drip applications refer to removing the condensate that forms in the steam main and steam supply lines versus condensate that forms at the actual process (heat exchanger, jacketed kettle, radiator, etc.). When steam loses its heat energy due to radiation through the pipe walls, condensate forms in the pipes. This condensate needs to be continuously removed.

It is recommended that drip leg steam trap stations be placed every 150 to 300 feet apart on straight runs of piping, before critical equipment such as regulators and control valves, at low points, at changes of elevation or direction, and upstream of any valve that can close. Traps used for this application are referred to as drip traps and have small condensate capacities in contrast to process traps. Drip traps are not normally relied upon to discharge the air from the system. Air removal is performed by the process traps and air vents located throughout the system. It is especially critical during system start-up to remove air to allow steam to quickly enter and heat up the piping. Start-up time can be significantly improved with efficient and effective air removal.

During start-up, when the piping system is cold and steam begins to flow through the pipes, steam condenses rapidly because of the energy required to heat the cold surfaces. Condensate is being generated at a maximum rate and the steam pressure - used to push the condensate through the steam trap into the return line - is at a minimum. If the steam traps are sized based upon normal running loads and normal system pressures, they would be undersized for a start-up condition.

In a supervised start-up, condensate drain valves located throughout the system are manually opened to drain large amounts of condensate generated by the cold piping system, relying less on the steam traps. Therefore, the steam traps selected for a system with a supervised start-up can be more closely sized for the actual normal running load. To simplify selection and reduce inventory, it is reasonable to consider a single trap that can operate over a wide pressure range.

For instance, a thermodynamic disc steam trap will operate over a wide pressure range which allows it to be applied across multiple system pressures within the manufacturer's recommended operating range. Conversely, mechanical steam traps such as float-type and inverted bucket traps offer multiple pressure range options which must be applied properly. If a facility has multiple operating pressures (e.g., 125 psig, 60 psig, 15 psig) and prefers using float-type or inverted bucket steam traps on drip applications, then the steam trap orifice may be selected based on the highest system operating pressure. In this example, selecting a steam trap with at least a 125 psig maximum operating pressure (PMO) will allow operation on all pressures up to 125 psig.

Proper sizing of steam traps on drip applications is based on the actual running condensate load formed between each correctly designed and properly installed drip leg station. Additional condensate load upon start-up must be considered.

A common approach for sizing drip traps is the calculated condensate load with a 2x sizing factor applied to account for start-up load. For comprehensive information on condensate loads for steams traps, including calculation of running and start-up condensate loads for drip applications, consult the latest edition of ANSI/FCI 13-1, Determining Condensate Loads to Size Steam Traps.

For drip applications where steam trap drip leg stations are properly installed every 150 – 300 ft., size the steam trap for 2x the running condensate load. The appropriate drip trap connection size is typically ½" or ¾".

Additional sizing considerations beyond the recommended guidelines, as stated above, are drip legs installed at the end of mains and supply lines, in areas of poor or missing insulation, and where extended runs exist between steam traps. Greater condensate loads can be expected in these instances.

Care must be taken in selecting the appropriate *type* of steam trap for drip leg applications. Certain styles of steam traps, by design, can back up considerable amounts of condensate behind them between discharge cycles. Condensate must never be allowed, under any circumstance, to back up into the steam distribution piping. Resulting water hammer can cause damage to components and poses a serious safety risk to personnel. Consult an FCI-member steam trap manufacturer for recommendations of appropriate steam trap types.

Selection and Sizing Considerations in Process Applications

Process applications refer to removing condensate and air at the origin of where the actual process is using steam. This process could be a heat exchanger making hot water, a radiator heating a room, or anything else that requires the use of steam. Steam traps used for process applications require larger condensate handling capability in contrast to steam traps that are used for drip applications. Steam traps used in process applications should be able to evacuate condensate as soon as it reaches the trap and discharge large amounts of air present in the system at start-up. (Separate thermostatic air vents are also recommended for process heat exchangers.) Process applications fall into one of two categories:

> *Batch* processes typically have steady demand as a batch of products is heated to a certain temperature. They tend not to experience rapid changes in steam pressure and steam flow. Common examples of such processes include **unit heaters, storage tank coils, jacketed vessels, and pipe coils.**
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> *Continuous* processes use steam to heat a continuously flowing product. The modulation of a control valve on the steam supply line results in rapid change in steam pressure and flow. Common examples of such processes include **heat exchangers, air handling coils, and instantaneous water heaters.**

The largest condensate load occurs when the maximum steam pressure is present (when the temperature gradient is highest) in the heat exchanger (HX). However, if the steam trap is selected based on the maximum condensate load at maximum pressure, it will not be adequately sized at lower differential pressures. This is because the capacity of a steam trap depends on the differential pressure across the trap (less pressure differential means less capacity) and trap capacity decreases **at a significantly faster rate** than condensate load when the steam pressure drops. When temperature control valves are used to control steam flow to a HX, the pressure may reduce to 0 psig or less. The pressure available to discharge condensate would then be based on head pressure of the drip leg. (A drip leg length of 14" will produce a head pressure of approximately ½ psig.)

Proper sizing of steam traps on process applications requires more attention than drip applications due to varying load and operating conditions. Appropriate safety load factors should be applied to account for these condition variations which can be difficult to predict or calculate. Therefore, trap selection should be based on its ability to rapidly adjust to load and pressure changes as well as quickly dispel air at start-up.

Sizing and selection of the proper steam trap on a process application is largely dependent on specific steam-using equipment and how it is controlled. Like steam traps on drip applications, sizing will still be based on the actual condensate load as well as an appropriate sizing factor. However, process applications are not steady-state and therefore require greater scrutiny. If a mechanical steam trap such as a Float & Thermostatic (F&T) is used, consideration must also be given to the maximum steam pressure that the trap may experience, which is typically the supply pressure to the inlet of the equipment or steam supply control valve.

Specialized applications such as submerged coils and cylindrical dryers are subject to steam locking due to the inability of condensate to drain by gravity to the steam trap based on installation limitations. An intermittent and controlled release of steam through the steam trap may be required to maintain continuous condensate discharge and prevent disruption of heating. Consult an FCI-member steam trap manufacturer for additional information and selection guidelines.

The type of steam trap selected must be appropriate for expected operating parameters of the steam-using equipment. For instance, heat exchangers heating a continuously flowing fluid with varying flowrate and supplied with a modulating control valve require a steam trap that can rapidly adjust to load and pressure changes as well as quickly dispel air at start-up.

For comprehensive information on determining condensate loads for various process applications, including appropriate sizing factors (often referred to as load safety factors), consult the latest edition of ANSI/FCI 13-1, Determining Condensate Loads to Size Steam Traps. For selection or sizing of appropriate steam trap types, consult an FCI-member steam trap manufacturer.

Selection and Sizing Considerations in Steam Tracing

Steam tracing refers to using steam to indirectly elevate - by conduction - the temperature of a product or process by using tubing or some type of jacketing device filled with steam. In a typical steam tracing application, stainless steel or copper tubing is filled with steam and is installed outside of a pipe or tank containing material that requires heating.

For vertical piping, tracing tubing may be coiled while for horizontal piping the tracing tubing should run parallel with a slight pitch towards the steam trap. Tracing tubing should not be coiled around horizontal piping as this would create low points for condensate to collect making temperature control more difficult. The steam inside the tubing transfers its heat to the material in the pipe or tank; therefore, preventing it from freezing or lowering its viscosity to allow it to flow more easily.

A steam trap is required for tracing to remove the condensate and air from the system. Application requirements will determine if condensate needs to be removed from the system as soon as it reaches the steam trap or if backing up condensate behind the steam trap (subcooling) is appropriate. Consult an FCI-member steam trap manufacturer for recommendations of appropriate steam trap types.

Conclusion

Steam traps are critical devices for the efficient and safe operation of steam systems and, therefore, must be selected and sized appropriately for the application they will serve. In addition to the information presented in this tech sheet, consideration must also be given to materials appropriate for the installation environment and condition of the boiler feedwater, as well as the maximum pressure and temperature capability of the materials selected. ANSI/FCI 69-1 Pressure Rating Standard for Steam Traps is a recommended resource for such information.

The Steam Trap Specification sheet should be consulted for a summary of the information to consider when selecting and sizing steam traps. Access the Steam Trap Specification on FCI's website: https://www.fluidcontrolsinstitute.org/fci-education-steam-traps.asp.