Steam Trap Operation and Troubleshooting

Steam Traps
Steam traps are devices that automatically discharge condensate and non-condensable gases from steam lines and heat exchangers while retaining live steam. They can be located before and/or after heat exchange processes, on the main steam header, and along horizontal runs of steam lines. Steam traps have three important functions:

- Promptly evacuate the condensate that forms when steam gives up its heat
- Prevent the escape of live steam
- Remove non-condensable gases, such as air and carbon dioxide

Properly installed and operating steam traps help improve the efficiency of a steam boiler system by keeping the distribution lines and processes filled with dry steam, removing the non-condensable gases that can form an insulating barrier on heat transfer surfaces and contribute to corrosion, and making hot condensate available for recycling. Conversely, improperly installed and maintained steam traps reduce the efficiency of a steam boiler system and increase operating costs. Steam traps that fail open allow live steam to pass, which wastes energy, water, and water treatment chemicals and increases operating costs. Steam traps that fail closed will not properly evacuate condensate. The resulting buildup of condensate causes steam lines and heat to become waterlogged, which prevents the flow of steam to the processes being heated.

Types of Steam Traps
Steam traps are available in a variety of designs that can offer advantages in different applications. Three basic designs are common.

**Mechanical steam traps** employ a bucket or float that rises and falls based on the condensate level in the trap. This rising and falling is used to either open or close a mechanical valve that allows condensate to pass. The inverted bucket trap and the float and thermostatic (F&T) trap are common mechanical steam trap designs. Inverted bucket traps are particularly common due to their ruggedness and ability to handle variable steam loads, remove air and non-condensable gases at steam temperatures, and resist water hammer.

**Thermostatic steam traps** use a valve that opens or closes in response to temperature changes. In the presence of steam, the thermostatic element expands, which closes the trap and holds steam back. When condensate forms and the temperature drops below the steam temperature, the thermostatic element contracts, which opens the trap and allows condensate to pass. These traps do not handle water hammer very well. A common type of thermostatic trap is based on the expansion and contraction of a bellows.

*Red is steam, blue is condensate

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Thermodynamic steam traps use a disc that rises and falls based on the variations in pressure that occur as steam and condensate pass through the trap. On startup, the pressure of the incoming condensate raises the disc allowing condensate to pass (Figure i). As hot condensate flows through the trap under the disc, flash steam forms to create a low pressure area under the disc that draws it toward the seat (Figure ii). When the flash steam pressure above the disc is greater than the pressure underneath, the disc is forced down to close the valve (Figure iii). As the flash steam in the upper chamber condenses, the pressure falls causing the disc to be raised by the now higher condensate pressure and the cycle repeats (Figure iv). Thermodynamic disc traps do not handle variable loads or removal of air and non-condensable gases very well. However, they are very compact and resist water hammer.

Troubleshooting Steam Traps
Malfunctioning steam traps can literally cost thousands of dollars per year in wasted steam, energy, water, and treatment chemicals. Traps that fail open continuously pass steam into the condensate return system and have the same impact as a steam leak.

You may be able to tell if a steam trap has failed open by visually inspecting the vent on condensate receivers or feedwater tanks for the presence of flash steam. However, a steam trap survey using an ultrasonic steam trap tester, infrared camera, or infrared temperature gun is a much more reliable way of identifying operational problems. The cost of a routine steam trap survey is far outweighed by the operational savings associated with reliable trap operation. Below is a table that shows the normal failure position for different types of steam traps and how to tell if you have a failure.

<table>
<thead>
<tr>
<th>Type of Steam Trap</th>
<th>Normal Failure Mode</th>
<th>Temperature Upstream of Trap*</th>
<th>Temperature Downstream of Trap**</th>
<th>Operational Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float and Thermostatic Trap</td>
<td>Open or Closed</td>
<td>Hot</td>
<td>Intermittent Hot and Cold</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hot</td>
<td>Hot (continuous same temperature as upstream of trap)</td>
<td>Steam Blowing by Trap (Failed Open)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cold</td>
<td>Cold</td>
<td>Condensate Flooding the Steam Line (Failed Closed)</td>
</tr>
<tr>
<td>Inverted Bucket, Thermodynamic Disc, Thermostatic Bellows Traps</td>
<td>Open</td>
<td>Hot</td>
<td>Intermittent Hot and Cold</td>
<td>Normal</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

*Orange is steam, blue is condensate

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*Hot and cold are relative terms. Hot is as high as the steam temperature at a given pressure and cold can be as high at 200°F.