STEAM TRAPS IN KILN SERVICE

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Wherever steam is generated and used ... for power ... for processing ... steam trapping is an essential part of the system. This is the story behind the piece of equipment that performs a vital function in the system - the temperature-activated steam trap.

Why a steam trap? Well, why steam? Steam is as familiar to today's housewife in her kitchen as it was to Robert Fulton in his boat. Steam is vapor ... created when heat is applied to water ... and capable of very efficiently transferring its heat to a substance or a piece of equipment. But, once the steam has transferred its heat, it reverts to water - it becomes condensate. Condensate must be removed from the system as rapidly as possible if peak efficiency is to be maintained in the heated equipment.

Thus, the important function of the steam trap - get rid of the condensate, air and other non-condensable gases, but not discharge or waste the live steam.

For the majority of heat transfer applications, an intermittent-action trap is the most efficient. That is why the thermostatic bellows trap is made to function the way it does ... to provide fast, intermittent valve action ... to cause immediate drainage of the condensate and the venting of air.

The application of a true balanced pressure accounts for the fast, positive, intermittent action of the bellows and valve. The bellows is partially filled with distilled water and a high vacuum is drawn on it to eliminate any air and ensure that only water remains. Let's take a look at how this steam trap works, and what the balanced pressure concept is, and why it is so important.

Remember that distilled water and no air is on the inside. Entering steam heats the bellows and increases internal vapor pressure until it is equal to that of the line pressure. Both pressures being in balance, the spring action of the bellows instantly snaps the valve shut.

As condensate, air, or any other non-condensables collect and build-up in the line, the bellows cools a few degrees below steam temperature. Pressure inside the bellows now decreases, allowing trap pressure to open the valve.

These traps are simple in construction. There is only one moving part - the bellows. No links, pins, pivots, levers or cams, no wobbling valves.

They have large capacity at low temperature differential. The temperature differential -- or call it temperature drop, if you like - required to open the valve is determined by several factors, the main one of which is the ratio of the bellows area to the orifice area. A trap with a high ratio of bellows area to orifice area needs less pressure drop inside the bellows to make it function. Consequently, it will operate on the least difference in temperature between the steam and the condensate.

The higher ratio requires the least pressure drop, and if you relate this to steam - less temperature drop is needed to open the valve. To put it another way - for any given difference in temperature, with valve orifices of equal area, the trap with the higher ratio will open its valve wider and have a greater capacity than a low ratio trap.

Another important factor in achieving large capacity at low temperature differential is high valve lift to give full-open orifice area. Many traps claim large valve size, but few afford full valve lift to give full orifice area. Large diameter orifices, unless the valves can be opened wide enough to take advantage of the openings provided for them, are meaningless.

Utilizing a true balanced pressure principle is the key to low temperature differentials in that the water fill inside the bellows will generate a pressure equal to, or less than, the steam pressure. Thus a water-filled bellows requires a less pressure drop to overcome the forces holding the valve closed, than does a bellows using a fill other than water ... because any other fill would create a vapor pressure greater than the steam pressure. It is also important that a good vacuum exist in the bellows and that no air is present, since air would increase in pressure along with temperature and, therefore, need a higher temperature differential to open the valve.

The combination of distilled water and very high vacuum allows water vapor pressure only inside the bellows. Operating entirely on the compression side of its free length, the bellows can accommodate the high valve lift we have shown to be so desirable, and will act as a compression spring to close the valve tightly when steam enters the trap. A bellows which operates on the extension side of its free length can sustain safely only one-quarter of the valve lift of a similar size bellows operating on the compression side.

Still another, and very important, feature is the fact that thermostatic traps will not air-bind. The low temperature differential required to open the valve gives these traps the ability to discharge air and non-condensables as well as condensate. Air may enter the boiler system either through the boiler make-up water, or air may be drawn back into the system due to condensation of the steam when the apparatus is shut down. Non-condensable gases such as carbon dioxide or carbon monoxide also may be present in the steam system.

Air and non-condensables have four detrimental effects. First, they occupy space, slowing down the rate at which steam can get to the equipment and do its proper job. Second, they reduce temperature. When mixed with steam, air reduces the temperature below what it should be at that particular pressure. For example, pure dry steam at 100 p-s-i-g has a temperature of 338 degrees farenheit. If five percent of air by volume is mixed with the steam the resulting temperature would be 332 degrees ... a temperature loss of six degrees.

Third, air and non-condensables reduce heat transfer. They deposit a film on the heat transfer surface and insulate it, thus resisting the desired conductance of heat. For example, a wall of air one-one-thousandth of an inch thick has the same insulating qualities as a slab of copper nineteen inches thick.

Fourth, air and non-condensables increase the chance of corrosion. Carbon dioxide and water, for instance, can combine to create highly corrosive carbonic acid.

So it is easy to see that you must get rid of air and non-condensables as well as the condensate. Thermostatic bellows traps are best at discharging air, again because of their ability to operate on lower temperature differential. The depressed temperature due to the air and gases cause the trap to open wide and remain open until the steam temperature reaches the trap.

Most thermostatic traps are freeze-proof, too. These traps remain fully open when cold so that condensate can drain from the trap by gravity should the system temperature suddenly drop. This is, of course, extremely important on outdoor installations.

However, no trap is freeze-proof unless it is piped properly. Piping from the trap must have considerable pitch for good gravity draining.

There must be no pockets or lifts after the trap because this will trap the water and nullify the freeze-proof feature of the steam trap.

Another advantage of thermostatic traps is that they will operate against any back pressure as long as there is a positive pressure difference across the trap to establish flow. Back pressure is sometimes created intentionally in order to increase the condensate return temperature. However, the increasing of back pressure is unintentional in most cases.

One of the principal features of bellows traps, and one mentioned only lightly earlier, they will not discharge live steam! Discharge of live steam is wasteful of the cost of the steam itself. Moreover, it contributes to undesirable fluctuating conditions in the process line. The difference between flash steam and live steam must be realized, however, because all traps discharge flash. Whenever water is discharged at a temperature higher than that prevailing at the trap outlet, part of that hot condensate will be re-evaporated.

A well-known example is the pop-off of a top-of-the-stove pressure cooker. That is flash steam, or the steam which is vaporized when hot condensate suddenly hits air temperature. You can identify it readily. It is all white with no clear jet ... a lazily drifting puff. It is proper to have flash steam because it is one indication that the trap is working. Now, if you want to determine whether it's live steam, you can tell it by its strong, clear jet and bluish tinge.

Operating advantages, as important as they are, can suffer from high maintenance cost. Thermostatic traps are as maintenance-free as can be. They do not require a change of parts to meet a pressure change in the process or equipment. Because steam pressure alone is the power which opens the valve, there is no need to change valves for pressure changes. Most plants have at least two or more steam pressures, therefore, using a trap that does not require a change of parts has these advantages: It eliminates parts stocking problems ... it simplifies maintenance ... it eliminates sizing errors.

The initial trap cost should not be the one and only consideration, one type of trap cannot be all things to all situations. Many factors enter into the cost of steam trapping as differentiated from steam traps themselves. Maintenance ... repair parts ... labor ... downtime losses ... steam waste (some traps waste enough steam in a year's time equal to three times the original cost of the trap) ... and more vital than any of these, inefficient operation of equipment.