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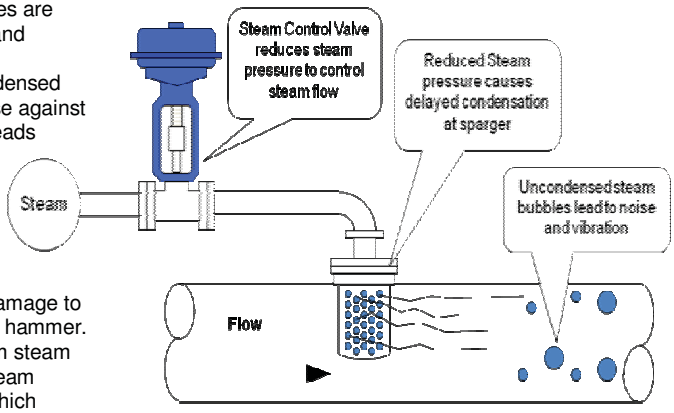
PSX Technical Bulletin

Internally vs. Externally Modulated Steam Control

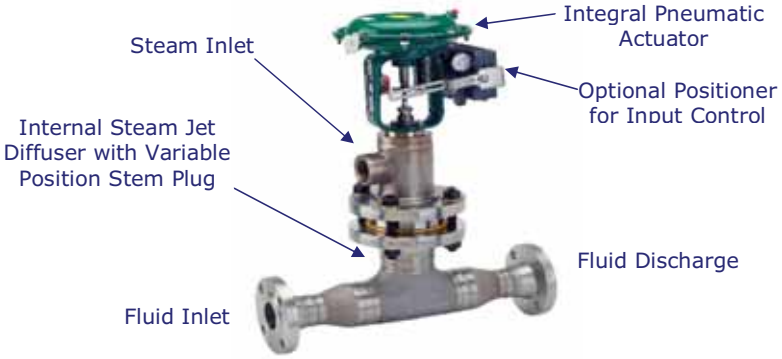
Externally Modulated Steam Control - Externally modulated steam control has been a common approach for Direct Steam Injection heating. This approach uses a remote steam control valve (PCV) to throttle (reduce) the steam pressure prior to a fixed opening steam injection point. Typically the steam pressure needs to be reduced at least 50% to control the amount of steam required for heating. As the steam injection point has a fixed opening area, the reduced steam pressure also reduces the velocity ***(sub-sonic flow)*** of the injected steam.

Issues: Effective steam condensation rates are reduced dramatically as steam pressure and velocity go down (subsonic flow).

- ***Low velocity steam*** leads to uncondensed steam bubbles, which tend to collapse against the pipe walls (Fig. 1). This is what leads to vibration & steam cavitation.
- ***Uncondensed steam*** can also travel past the temperature sensor which results in temperature control issues such as over heating.
- ***Process upsets*** are common and damage to equipment can occur from the steam hammer.
- ***Excessive Maintenance*** results from steam collapsing on the surface or in the steam injector, leading to excessive wear which Increases maintenance costs and reduces the heaters reliability.



Internally Modulated Steam Control – ProSonix' unique method of steam injection utilizes an internal steam control to precisely deliver the appropriate mass flow of steam for the required heating. This is achieved via an integral pneumatic actuator and a ***variable position stem plug*** in the steam jet diffuser. We do not throttle or regulate steam pressure. This design offers a precise method of steam control through a ***choked flow control delivery of the steam***. Choked flow is the phenomenon of accelerating a vapor to maximum velocity by creating a pressure differential through an engineered nozzle. By establishing choked flow, the ***steam mass flow can be metered*** to precisely control the heating of the liquid. This produces predictable results based on position of the stem plug. Through a ***variable-area steam diffuser***, steam flow is metered at the point where steam and liquid first contact and mix. Internally Modulated DSI heating controls the mass flow of the steam and not the pressure.



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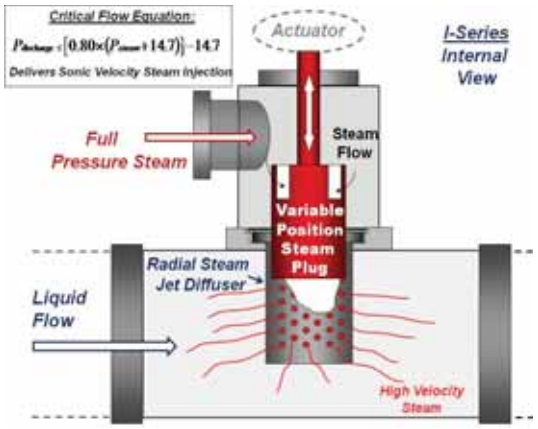
Advantages of Internally Modulated Steam …

- ***No Process Upsets*** *- High velocity steam flow optimizes the steam mixing and condensation with the liquid and eliminates problems with vibration and steam cavitation.*
- ***No Steam Control Valve (PCV) Required*** *This method eliminates the need for an external steam control valve or downstream mechanical mixing devices.*
- ***Reliable Temperature Control*** *Rapid and complete condensation of the steam allows for reliable temperature control of +/- 1 °F.*
- ***Self Cleaning Design*** *High velocity steam also is self cleaning and eliminates scale & mineral build-up on the steam diffuser.*
- ***Lower Maintenance Costs*** *Proper condensation of the steam eliminates excessive wear on the surface of the PSX Heater's mechanical surfaces.*
- ***Energy Savings*** *The low pressure drop, typically 1-2 psig, reduces pump energy demand and simplifies process integration.*



The Importance of Steam Velocity for Effective Steam Condensation …

As discussed above, ***externally modulated steam control*** uses a remote steam pressure control valve to throttle (reduce) the steam pressure prior to a fixed opening steam injection point. Typically the steam pressure needs to be reduced at least 50% to control the amount of steam for temperature control. As the steam injection point has a fixed opening area, the reduced steam pressure also reduces the velocity ***(sub-sonic flow)*** of the injected steam.

In order to modulate steam control through a fixed area orifice, the pressure must be reduced significantly in order to change the specific volume enough to make the steam flow drop to match demand. If you look at the steam tables, the specific volume increases slowly until the pressure gets quite low. The 50% reduction for a starting control point of the PCV is used because it typically takes that large a drop to start to impact the operation of the heater.

The effect of reducing the steam pressure with a steam pressure reducing valve to control the steam flow has the following impacts:

- ***Temperature Control Issues*** *- It makes temperature control difficult since the effect of the steam valve is non-linear.*
- ***Sub-sonic Steam Flow*** *- The big drop in steam pressure makes the pressure differential between the steam and fluid too small to insure high velocity steam throughout the operating range.*
- ***Steam Cavitation*** *- Poor steam condensation, resulting from low velocity, can lead to the problems in operation such as process upsets (steam cavitation) and pre-mature wear of internal steam trim.*

ProSonix' unique design with its internally modulated steam control will produce reliable and predictable process heating results for your process. High velocity steam injection assures rapid and complete condensation of steam.

For additional info, please visit us at … www.pro-sonix.com