process HEATING

Heat Exchangers

10 Tips to Optimize Your Steam-Injection Heating Application

These recommendations will help you design a safe, reliable heating system.

A direct steam-injection system can provide precisely controlled hot water to the pasteurizer in food and beverage packaging operations.

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Many companies have a need for the heating of fluids in their facilities. These can include heating of fluids to improve chemical reaction, slurries for production needs, wastewater processing, hot water for equipment washdown and parts cleaning, and many other fluid-heating requirements. Achieving a fluid target temperature can reduce chemical usage, improve processing speed and — in washdown or clean-in-place (CIP) cleaning applications — help ensure that regulatory requirements are met.

Steam-injection heating — sometimes known as direct steam-injection heating — is a direct-contact method of heating where steam is directly injected into the fluid to be heated. Heating can be done as an inline installation, where the direct steam-injection (DSI) heater is used to heat a continuous fluid stream, or with heaters commonly called spargers. Steam-injection heaters can be tank mounted or placed in nearby piping.

While this article is focused on steam-injection heating, many of the recommendations can be applied to indirect contact-heating devices such as heat exchangers. Below are some tips to consider when evaluating a steam-injection heater to optimize your process heating application.

1. Communicate All Relevant Application Information

Most manufacturers will have available an application survey. This is designed to help guide you through the evaluation of your steam-injection heating application. Basic information needed includes flow rates (high, low, nominal), inlet and discharge temperatures and steam pressure. Other data such as fluid names, physical properties (solids present, specific gravity, specific heat and viscosities), liquid pressure and proper flow velocities are all important because they help in the equipment selection process.

Remember, communicating any current or expected process issues or improvements can help in evaluating your application needs. Also, be sure to provide details on your heating process. For example, a one-pass inline, heater is a different application than a tank-heating system with requirements for turndown to support low daytime process needs and high heat load requirements such as end-of-shift cleaning.

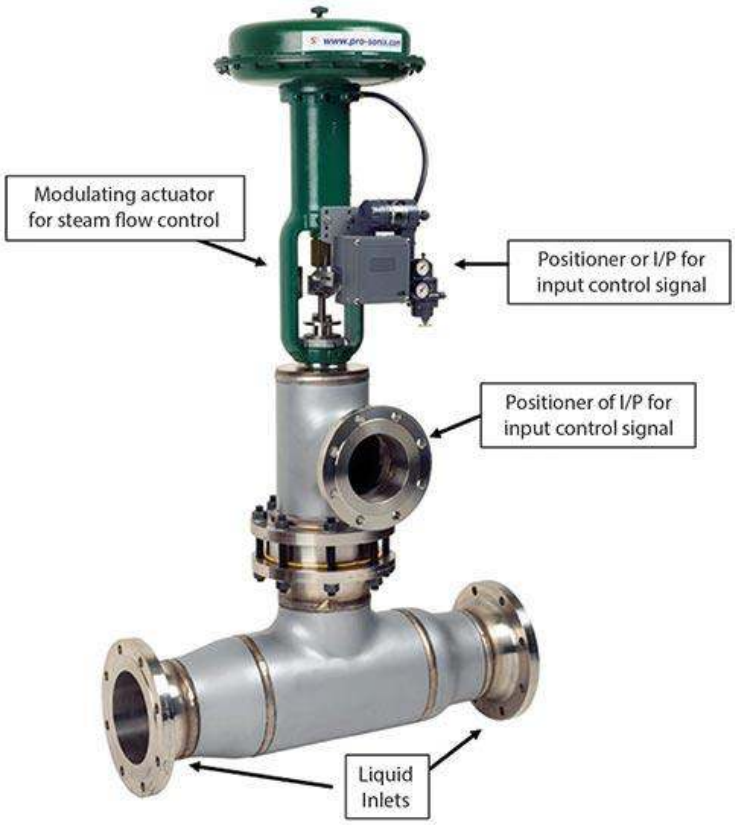

FIGURE 1. *Internally modulated steam flow designs do not reduce steam pressure, they control the mass flow of the steam. This is an example of a heater with integral internally modulated steam flow control.*

2. Understand the Difference in Steam Flow Control Devices

There are two types of steam flow control designs. The first is the use of an external pressure-reducing valve, which adjusts incoming steam pressure to the heater to make changes in temperature output. Externally controlled designs have limited turndown. Reducing the steam pressure narrows the essential steam-to-liquid pressure differential, restricting turndown.

The other design is internally modulated, where the steam-control device is directly coupled to the heater (figure 1). In this design, steam pressure is not reduced. Instead, the mass flow of steam is controlled, maintaining full steam pressure across the range of operation. This design can provide higher turndown.

3. Identify Steam Pressure at the Point of Heating

All boilers and steam headers will have a steam pressure rating; however, you want to identify your steam pressure requirements at your heating location. This means that from your steam header, you should calculate your line losses due to friction, fittings (elbows, tees, etc.) and components such as valves and strainers to establish what your design steam pressure is at the heater location.

4. Size for Actual Needs to Optimize the Control Operating Range

One of the more common problems is overestimating application conditions. Oversizing the heater's capacity — relative to the actual design operating conditions — can lead to control issues. If the actual conditions you will be operating at are at the low end of injector capacity, you will end up operating within

a very small control band. This can lead to temperature control issues and premature wear of steam injector components. Like most valves, sizing to use 40 to 80 percent of the operating range is optimal. Confirm with your steam-injection heater supplier that they offer variable sets of steam trim sizes to upgrade the heater should future heating needs change.

FIGURE 2. *Different types of heaters have specific pressure-differential requirements. This is an example of radial multi-port jet diffuser design mounted on a hot water tank.*

5. Maintain Proper Steam and Liquid Pressure Differential

Steam-injection heating requires a pressure differential between the steam and liquid, whereby the steam pressure must be higher than the liquid pressure. Proper pressure differential is critical for rapid steam-jet condensation. If the proper differential is not maintained, it can lead to steam flashing (steam hammer or water hammer) and premature wear of steam-injector components. Different types of heaters (jet diffusers, eductors, etc.) have specific pressure-differential requirements (figure 2). Steam-injection heater manufacturers can provide the maximum allowable backpressure for their specific heater design.

6. Pump Flow Changes Should be Ramped

It is important to avoid flow fluctuations that occur faster than the temperature control loop can respond. Steam-injection heating is responsive to control changes. Also, unlike indirect contact heaters such as heat exchangers, there generally is no lag between the process control calling for the addition of steam and the heater responding. Pump flow changes should be ramped, allowing the temperature control loop to respond.

Keep in mind that rapid changes in flow rate will lead to continuous control-loop adjustments, which can impact temperature control. Also, rapid drops in liquid flow can lead to steam flashing until the temperature control can respond.

7. Proper Steam Line Setup Leads to More Reliable Heater Operation

Your steam supply and incoming steam line play an instrumental role in the performance and reliability of your steam-injection heating process (figure 3).

Dry saturated steam is recommended. Some superheat can be present; however, this must be identified in application review. Check valves can be used to prevent liquid backflow into the steam line and steam trap, and drip legs remove condensate. A steam strainer will remove solid particulate.

8. Confirm Your Boiler Can Supply the Steam Required for Your Heating Application

Steam-injection heating can come online quickly, which makes it suitable for intermittent heating requirements. Keep in mind though, that when heating is called for, the heater will move to the fully open position. If the heater's steam demand is close to the boiler's available output, this can draw down your boiler faster than desired. If you find that initial startup of your heater is drawing down your boiler, you can set up a ramp-up procedure to control the opening sequence of the heater, which will allow your boiler to recover faster.

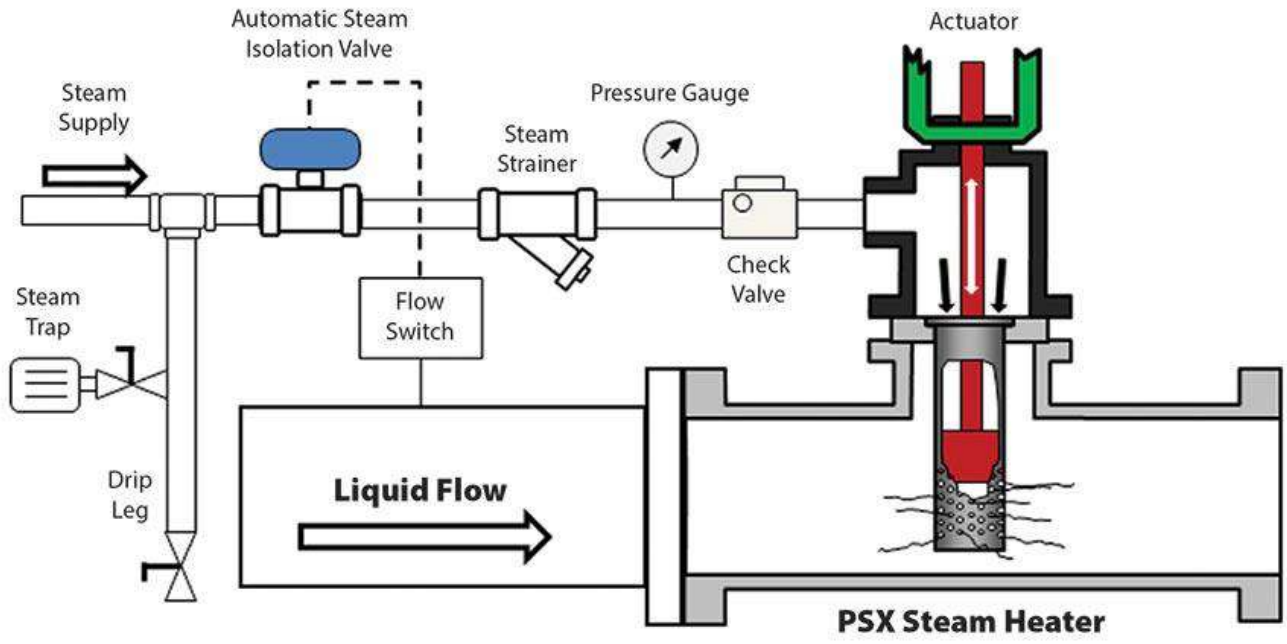

FIGURE 3. *Your steam supply and incoming steam line play intrumental roles in the performance and reliability of your steam-injection heating process. This illustration provides an example of proper steam line setup.*

9. Process Monitoring Can Help Ensure Stable Heating Operation

Examples of process heating monitoring for direct steam-injection include:

- Flow switch on incoming liquid line tied to steam isolation shutoff for loss of liquid flow.
- Interlock heater operation to liquid pump operation.
- High temperature alarm for excessive temperature rise.

The PLC or temperature controller should be set up to monitor heater operation to prevent process upsets.

10. Follow Recommended Installation Guidelines

Proper installation of your heater will lead to reliable performance. In addition, proper installation techniques help reduce process upsets and can extend the time between maintenance cycles.

The piping layout should be reviewed in accordance with the manufacturer's installation guidelines. Proper instrumentation and temperature control-loop layout will improve your process heating reliability.

In conclusion, understanding that your steam-injection heater is a high energy transfer device —and not a control valve or a mixing valve — is important to designing your process heating system. The above recommendations should help you design a safe and reliable heating system.

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