

ProSonix Technical Bulletin

What Causes Steam Cavitation in Process Heating?

We are often asked about the importance of the relationship between the liquid pressure and the steam pressure. The Steam and liquid pressure are related to one another in several ways.

First and most important is the need for a differential between the steam pressure and the liquid pressure.

All Direct steam injection heaters rely on high steam velocity to drive the condensation of the steam and transfer energy in a stable and rapid manner. This differential will determine the velocity of the steam. The ideal case is where the liquid pressure is less than 60% of the absolute steam pressure. Many direct steam heaters will not operate if that condition is not met, particularly those that utilize an external steam control valve to adjust the amount of steam injected. In externally controlled heaters, the steam pressure is substantially reduced through the steam control valve, so the available steam pressure is much lower than the design pressure.

Second, minimizing the differential between the steam pressure and the liquid pressure presents fewer process upsets, leading to more stable DSI heater operation (no hammer & vibration), better pump integration, and improved temperature control. All these can be optimized by maintaining high velocity steam injection to promote rapid and complete condensation of the steam.

The ProSonix Steam Jet Diffuser heater design utilizes a unique internal steam control design whereby the steam and liquid pressures can be much closer and still provide high velocity steam injection. In our design, we can operate with liquid pressures up to 80% of the absolute steam pressures.

In general, the pressures should meet the following condition:

$$P_{liquid} \leq ((P_{steam} + 14.7) * .75) - 14.7 \text{ (psi)}$$
$$P_{liquid} \leq ((P_{steam} + 101) * .75) - 101 \text{ (Kpa)}$$

Equation 1

There are a variety of ways to meet this condition in real world applications.

1. Choose a steam supply high enough to meet the requirements
2. Reduce the liquid pressure
 - a. Move the heater to a higher elevation
 - b. Trim pump impellers
 - c. Change pressure settings in control loops

Standard ProSonix heaters are designed to operate on steam pressures as high as 300 psig (2000 kPa). Although it is possible to operate at steam pressures above 300 psig, external factors such as leakage and seal ratings, required custom engineered designs. In addition, there is no operational advantage to operate at higher steam pressures since in most cases, the steam velocity will not increase significantly, once the conditions in **Equation 1** are met.

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