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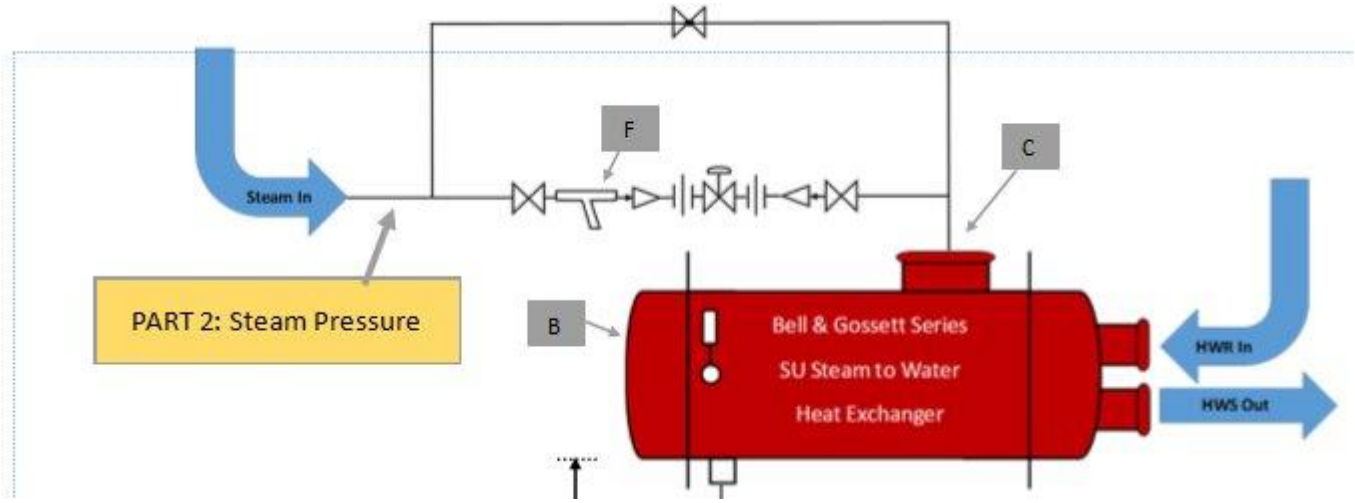
Why Use Low Steam Pressure: Steam Heat Exchangers Basics (Part 2)

A recent engineering graduate asked a question about reducing steam pressure before using the steam for heating and domestic water heat exchangers: Why do you tend to use low-pressure steam in HVAC and domestic water heat exchanger selections?



When selecting a heat exchanger, the diameter is determined by the design flow rate and tube velocity limits. The LMTD (log mean temperature difference) ends up being a big factor in determining the heat exchanger length. The closer the shell-side steam temperature is to the average tube-side water temperature, the longer the exchanger becomes and the more square feet of heat transfer surface is required.

If we select a steam-to-water heat exchanger—also called a convertor—at 30 PSIG entering steam pressure, we get a shorter unit than if we select it at 5 PSIG entering steam. There's slightly more latent heat in higher pressure steam, but the overriding factor comes from the steam temperature. 30 PSIG steam is 274°F while the 5 PSIG steam is 227°F.

You'll need more heat transfer surface at 5 PSIG than at 15 PSIG. If you had 5 PSIG in the shell vs. 15 PSIG, you would need about 35% more surface. This increase in surface using 5 PSIG instead of 15 PSIG will result in a cost increase of about 50% for the installed heat exchanger.

Steam Temperature and Enthalpy

Pressure (PSIG)	Temperature (°F)	Enthalpy (BTU per Lb.)
2	219	1153
5	227	1155
10	239	1160
15	250	1163
30	274	1172
50	298	1179
75	320	1185

It would seem to be a good idea to use the higher steam pressure, until we look at what we lose when using this higher steam pressure. We lose some temperature control and flash steam.

By the way, when selecting the heat exchanger, we normally assume a 50% pressure drop through the steam control valve for authority. If the control valve was pre-selected and the Cv of the valve was known, we could use the actual expected pressure in the shell. In general, the 50% rule of thumb is close. So the following discussion assumes the pressure in the heat exchanger and not the pressure to the control valve, which is higher.

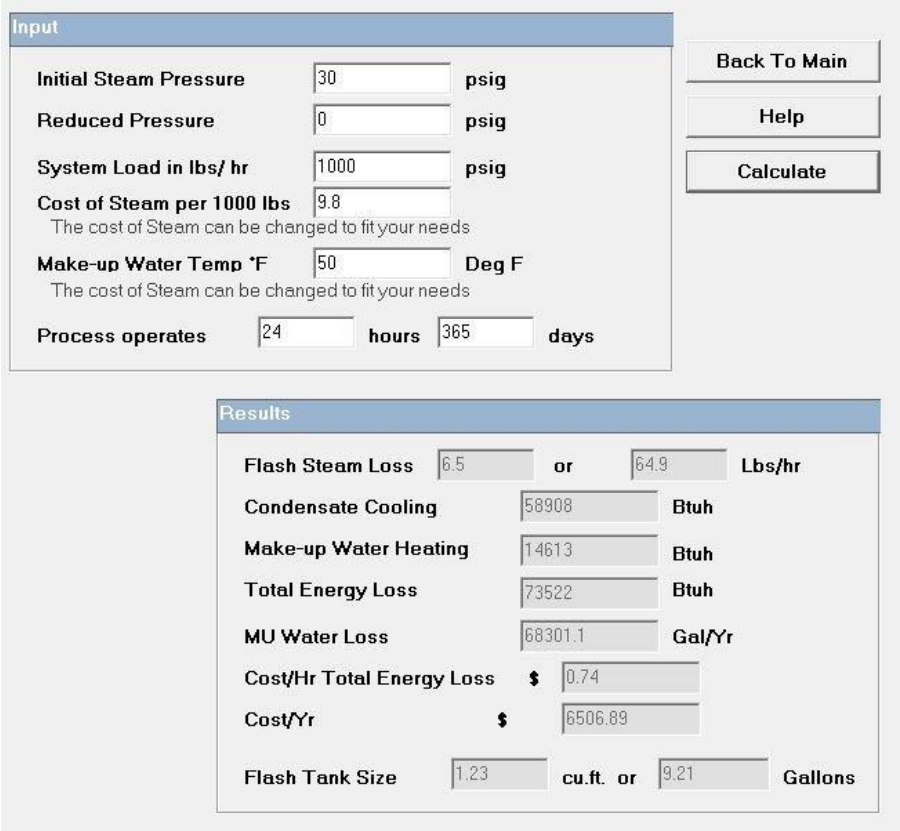
The Effect of Steam Pressure on Temperature Control

The control valve has to react to changes in the temperature of the tube-side liquid. When the control valve opens on a call for heat, the system is normally at part load conditions. The steam temperature is greater at higher pressures and the LMTD is higher. When using higher steam pressures, the control valve may have a higher temperature overshoot when first opening. This could be a real problem in systems with large changes in instantaneous loads such as domestic water applications, and less of an issue in HVAC applications. Lower steam pressure gives better temperature control.

The Effect of Steam Pressure on Flash Steam

Most condensate return systems are vented. There are condensate return systems, similar to the Kadant Liqui-Mover® condensate pumps we represent, which are closed—but in general, most return systems are vented. When the hot condensate enters into the gravity return lines and vented condensate units, it flashes into vapor. If you use the Xylem Hoffman steam loss calculator on our website, you can calculate flash loss.

We lose 6.5% to flash steam when the condensate temperature is at 274°F (30 PSIG) vs. 1.5% at 227°F (5 PSIG). This has two effects. The difference in flash steam percent will cost about 58¢ per hour at design capacity. This cost is based on $9.80 per 1000 lb. of steam and entering makeup water at 50°F. You can estimate the cost of steam for your project using the U.S. Department of Energy Benchmark the Fuel Cost of Steam Generation. The Hoffman program lets you change the costs to match your local actual costs.



The second effect is the potential damage caused to traps, condensate pumps, and other parts in the condensate system when we flash to vapor. Systems with higher pressures will often have flash tanks to control the flash and reduce damage, but that will be a topic for a later Monday Morning Minute.

Conclusion: In HVAC and domestic heat exchanger applications, try to use lower steam pressures when available.

Contact your local representative for more information on Bell and Gossett Heat Exchangers, EspPlus Selection Programs, and Kadant Liqui-Mover®.