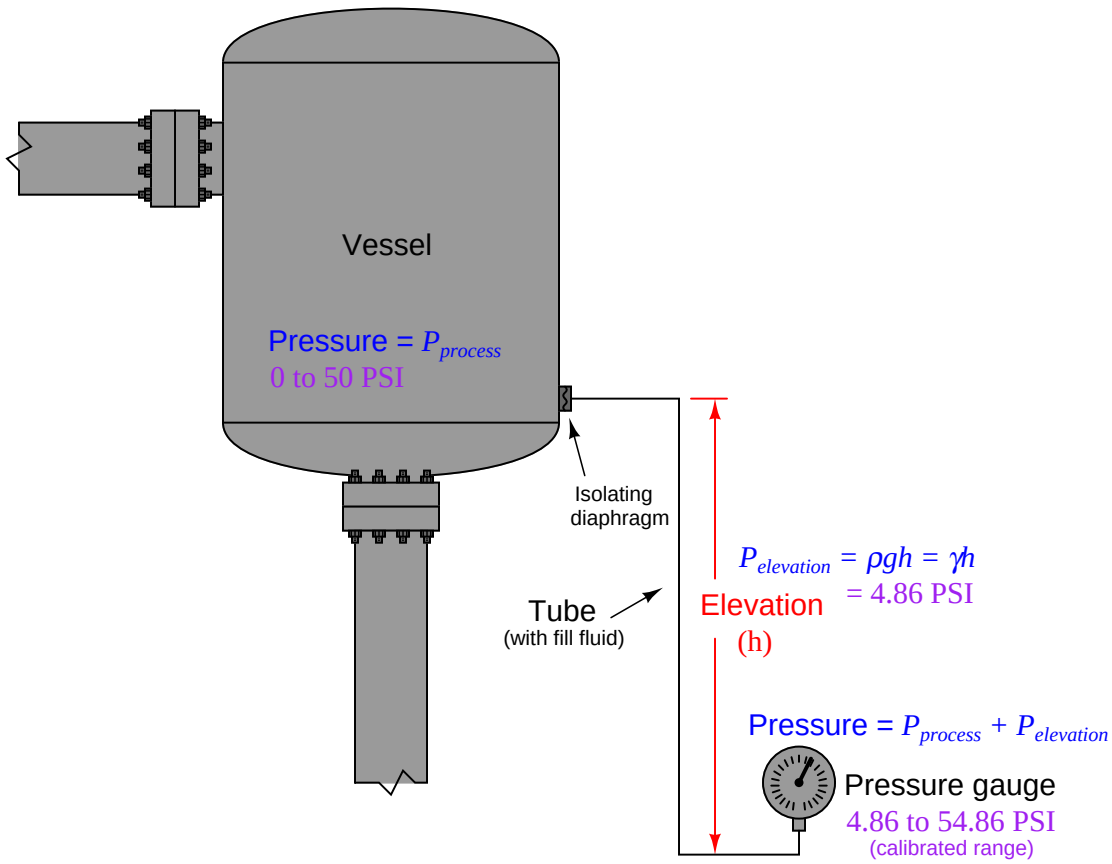
19.6.8 Self-purged impulse lines

One of the advantages of purging a pressure instrument impulse line with gas rather than with liquid is the elimination of measurement error due to the pressure generated by a vertical column of liquid. We investigated an example of this phenomenon in the "Remote and Chemical Seals" subsection where a liquid-filled vertical run of capillary tube 12 feet high created an additional hydrostatic pressure of 4.86 PSI sensed by the pressure gauge. This hydrostatic pressure caused the gauge to read falsely high, so that instead of registering 0 to 50 PSI as the process vessel pressure ranges from 0 to 50 PSI, the gauge instead reads 4.86 PSI *extra* at all points: reading 4.86 to 54.86 PSI as the process vessel pressure goes from 0 to 50 PSI:



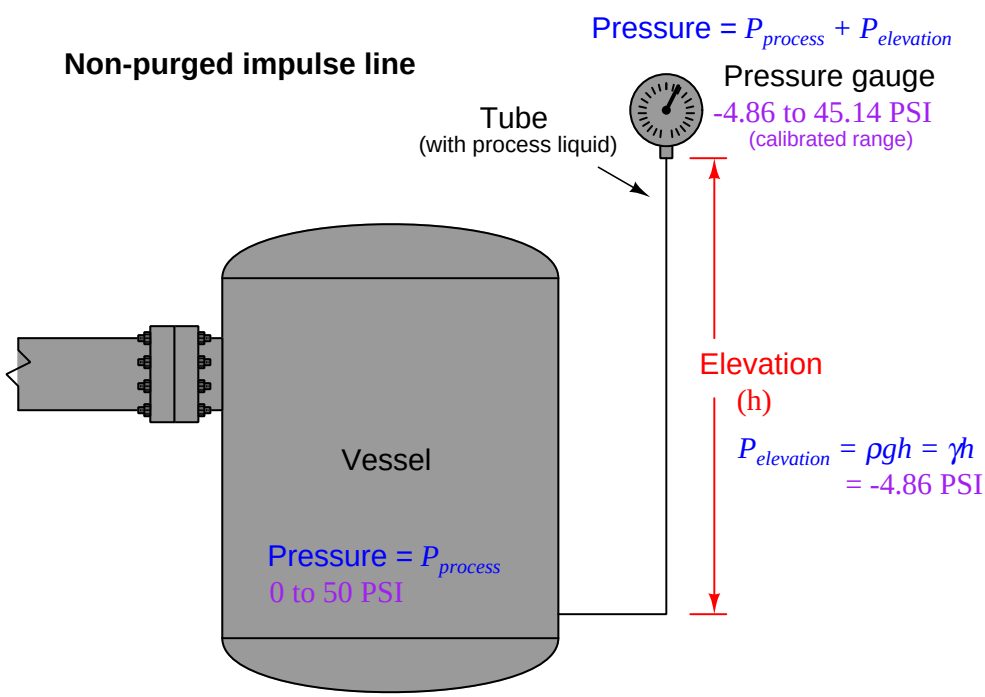
This measurement error may be compensated by shifting the "zero" calibration of the pressure gauge by 4.86 PSI, forcing it to register 4.86 PSI *less* than the pressure it senses at its input port. Only by custom-calibrating the pressure gauge in this manner can we solve the problem created by that 4.86 PSI hydrostatic pressure ($P_{elevation}$).

We also learned in the "Filled Impulse Lines" subsection that this hydrostatic effect is not limited to remote-seal capillary systems but is endemic to *any* significant vertical length of tube filled with

any liquid. A gas-purged impulse line, by contrast, generates negligible pressure due to elevation differences simply because the density of most gases is negligibly small.

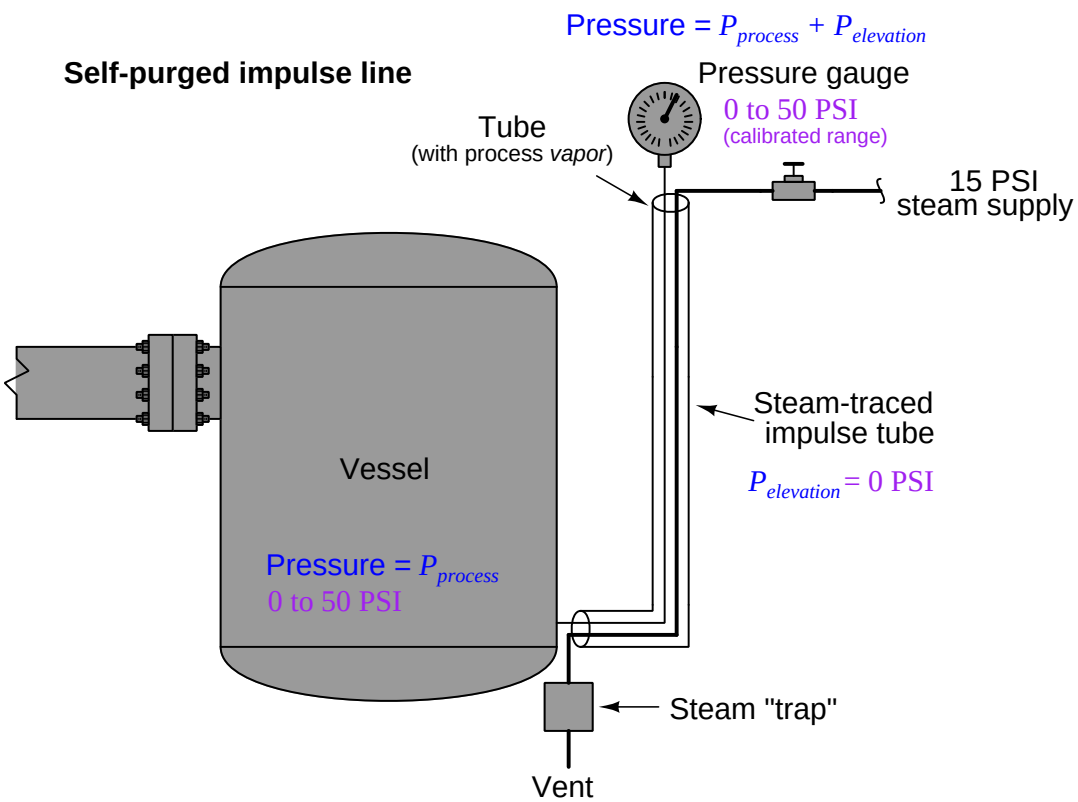
An interesting variation on the theme of gas-purging for instrument impulse lines is the use of an external heat source on those impulse lines to cause the process liquid to *boil* and vaporize within the lines. This technique, of course, only works for process liquids that are easily vaporized with modest applications of heat, but in many processes this is practical. Examples of process liquids amenable to this treatment are propane, butane, and any cryogenic[28] liquid. If we use heat-traced impulse lines, the thermal energy added to the lines maintains their interiors in a gaseous state rather than a liquid state, eliminating any vertical liquid columns inside the lines and therefore eliminating any pressure measurement error resulting from elevation between the pressure instrument and the process connection point.

Self-purging works best in installations where the pressure-sensing instrument is mounted *above* the process liquid level, and where the presence of liquid inside the vertical run of impulse line extending down from the pressure instrument to the vessel would otherwise create a *negative* pressure offset. Shown here is an example of an installation where a vertical impulse line creates a negative pressure measurement error:



[28] "Cryogenic" simply refers to a condition of extremely low temperature required to condense a gas into liquid. Such liquids will flash into vapor if raised to room temperature, and so it is quite easy to make impulse lines self-purging in such cases.

Heating this impulse line causes any liquid inside of it to vaporize, forcing remaining liquid to flow out the bottom of the line and back into the process vessel, "self-purging" the line with vapor and thereby ensuring the pressure instrument senses actual process vessel pressure:



The ideal impulse line heat-trace temperature is greater than the *critical temperature* of the process fluid, so that no amount of process pressure can make it liquefy. This will ensure a liquid-free state inside the heated impulse lines even if process pressure happens to increase.

If any *other* liquids exist inside the vessel that will not vaporize at the same temperature, it becomes necessary to install a liquid *trap* at the bottom of the impulse line where this other liquid can accumulate without filling up the impulse line. Periodically draining this trap of accumulated liquid then becomes a regular maintenance task.

Self-purging does not work as well in installations where the process vessel is located above of the pressure-sensing instrument because liquid will continuously find its way into impulse line by gravity, where the sudden expansion from liquid into vapor will create pressure surges inside of the line. This will cause the pressure instrument to register intermittent "surges" of pressure, which is a worse problem[29] than having an hydrostatic offset.

[29] At least in the case of a liquid-filled impulse line generating its own hydrostatic pressure, that pressure is constant