Product Note, PN 426
Supply Pressure Effect Concerns for High-Flow Regulators Used in High-Pressure, Compressed Gas Applications

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Definition of Terms

Supply pressure is the pressure supplied to the high pressure or inlet side of a regulator.

Supply pressure effect (SPE) is a phenomenon that occurs in many pressure regulators in which the outlet pressure changes due to a change in the supply pressure. For pressure regulators that are not balanced, the outlet pressure will change as a result of changes in supply pressure. The SPE is relatively constant over the source pressure rating of the regulator.

Please refer to PN 403 for a more general explanation of SPE.

System Design and Usage Considerations

SPE varies significantly between different regulator models and designs. AP Tech has pressure regulators with SPE ranging from as little as 0.05 psi to as much as 5.4 psi. Higher flow regulators tend to have a larger SPE due to the size of the diaphragm relative to the poppet sealing area.

SPE is an issue in gas cylinder (source) applications where the supply pressure decreases as the gas is consumed. The outlet pressure increase due to SPE can be significant from a full to an empty cylinder. For example, an AP 1200 HR regulator with source pressure varying from 2,200 psig to 200 psig will have a pressure rise of 70 psi between. The calculation is:

Supply pressure decrease = 2,200 psig (full cyl) – 200 psig (empty cyl) = 2,000 psig

Delivery pressure rise = 2,000 psig x 3.5 psi/100 psi = 70 psig

Gauge Selection

SPE needs to be considered when selecting outlet pressure gauges (or transducers) in applications where the source pressure varies significantly. Regulators are adjusted to deliver maximum outlet pressure at maximum inlet pressure. Thus, SPE results in an outlet pressure to rise well above the maximum outlet pressure rating of a regulator as source pressure drops. One should select a gauge with a pressure rating to account for the maximum operating pressure rating of the regulator plus the SPE resulting from the application.

An example of a worst-case scenario is the AP 9000 VS HR regulator. It has an SPE of 3.7 psi and a maximum source pressure rating of 3,000 psig. This means the outlet pressure would change slightly more than 85 psig as source pressure falls from 2,500 to 200 psig.

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The calculation is:

Supply pressure decrease = 2,500 psig – 200 psig = 2,300 psig

Delivery pressure rise = 2,300 psig x 3.7 psi/100 psi = 85 psig

Maximum outlet pressure = 100 psig (rating) + 85 psi (SPE) = 185 psig

In this case the AP 9010 VS HR regulator requires a minimum gauge rating of 200 psig to ensure that the gauge is not damaged due to SPE.

Nitrogen Purging

System purging introduces a different SPE consideration. Nitrogen pressure for system purging is usually between 80 and 100 psig. If one adjusts a regulator to a given outlet pressure with purge nitrogen, the outlet pressure will decrease when process gas at a higher pressure is applied. For example, if one adjusts an AP 1200 series regulator to 50 psig outlet with 100 psig of supply nitrogen, and subsequently applies process gas at 1,100 psig, the outlet pressure actually decreases by 35 psi to 15 psig due to the SPE.

If one charges a regulator with high pressure, then shuts off the cylinder valve, proceeds to vent via the low pressure vent valve, the outlet pressure of the regulator will rise as the source pressure decreases. This means that if one pulses the vent valve, the regulator's outlet pressure will rise with each successive vent release due to the decreasing supply pressure.

High and Low Pressure Alarms

When using a regulator with a large SPE in applications with downstream high and/or low-pressure alarms, one must allow for a variation in outlet pressure when setting the alarm trip points. For example, if a regulator has a delivery pressure rise of 35 psi from a full to an empty source cylinder, the high-pressure alarm trip point needs to be set at least 35 psi above the operating pressure to account for the SPE. The low delivery pressure alarm should be set relative to the adjusted pressure at maximum source pressure.

When can one ignore SPE?

SPE is a non-issue with liquefied gas cylinder applications. The gases are in equilibrium with the liquid phase, and therefore, at a constant temperature they will provide a constant supply pressure until all the liquid is completely converted to gas.

Any application where the inlet pressure to the regulator is relatively constant, SPE is not a factor to consider. This means that for almost all point of use, distribution such as VMB (Valve Manifold Box) and line applications SPE is not a concern.

Please consult the factory or your local distributor for further information or assistance.