



Overview

Two stage means pressure reduction occurs twice. The two stages in a common body is a two stage regulator whereas two discrete regulators connected in series is two stage regulation. Both drop the incoming pressure in two steps, an intermediate pressure (outlet pressure of first stage which is inlet pressure to second stage) and an outlet pressure. Two stage pressure reduction mitigates supply pressure effect (SPE). The first stage is impacted by the device's SPE rating but the small change in intermediate pressure due to SPE has minimal impact to the second stage.

Thermal considerations

The cooling effect due to the gas expanding to a lower pressure, known as the Joule Thompson effect (JT), is mitigated by two stage pressure regulation. Separating the pressure drop into two stages also separates the cooling effect. Two stage regulators have limited impact with the cooling due to being one thermal mass. Two stage regulation, on the other hand, is used to effectively manage the cooling effect. The two pressure regulators are separated by tubing which limits the heat transfer from one to the other. Two regulators in series also enables more effective heating. The gas can be heated prior to the first regulator and in between the two regulators, which is not an option with a two stage regulator.

Two stage regulator safety considerations

The first major pressure drop downstream of the source vessel is where most problems occur and it is across the seat of the source regulator. Particles and moisture in the gas tend to precipitate out at the pressure drop. This leads to across the seat leakage in the source regulator, meaning an uncontrolled outlet pressure rise. If the outlet pressure of the source regulator is monitored, one can detect an across the seat leak. Unfortunately, a typical two stage regulator does not have a port to monitor the intermediate pressure. The first stage is source regulator and the first major pressure drop. This means that an across the seat leak of the first stage won't be detected and can result in a catastrophic failure, an outboard leak. An intermediate pressure rise to high pressure, beyond the

proof pressure rating, can cause a diaphragm leak.

Two stage regulators are recommended for B₂H₆ (diborane) service due to the characteristics of the gas. This is one of the few gases where a two stage regulator is recommended in UHP service. The gas tends to cause crystal formations which lead to across the seat leaks. Generally, the crystals cause an across the seat leak in the first and second stages which is noticeable prior to causing a diaphragm failure of the first stage.