THERMAL VACUUM GAUGES

Thermal vacuum gauges operate by sensing the cooling effect on a heated filament of the gases in the vacuum system. Higher pressures mean more gas molecules and higher cooling effect. Better vacuum means fewer gas molecules and lower cooling effect. Most thermal gauges are calibrated for air (nitrogen). Since different species of gas molecules with different masses, generate different cooling rates, a correction factor must be applied for gases other than air (nitrogen).

Thermal gauges are best used as qualitative indicators of vacuum level and trends, in applications such as system roughing pump down. They are also subject to contamination by liquids and organic vapors. This type of contamination can be limited by mounting the gauge sensor with the vacuum port oriented downward.

CAUTION: Since all thermal gauges utilize a hot filament, there is danger of explosion if exposed to combustible gases, especially at higher pressures.

Three general types of gauges are in common usage:

1. Thermocouple (TC) Gauge.

In this configuration, the temperature of a heated filament is measured by a thermocouple. At high pressures more filament cooling occurs, the filament temperature goes down and a characteristic temperature versus pressure curve is generated.

TC gauges have a slow response time since the thermal mass of the sensor delays temperature change. A lower pressure measuring limit of about 1 micron (1×10^{-3} torr) is the result of other cooling effects beginning to interfere with the gas cooling. An upper limit of about 2 torr represents the point at which turbulent gas flow begins to dominate over molecular gas flow

2. Pirani Gauge.

This type of gauge maintains the filament at a constant temperature, while using an electrical bridge circuit to measure the power required to do so. At higher pressures, more power is required to offset the additional cooling effects of the higher gas density. A characteristic power versus pressure curve is developed.

Pirani gauges have a faster response, since little temperature change takes place and changes in power can be quickly sensed. A lower limit of about 0.1 micron (1×10^{-4} torr) is the result of other cooling effects beginning to interfere with the gas cooling. An upper limit of about 2 torr represents the point at which turbulent gas flow begins to dominate over molecular gas flow

3. Convection Enhanced Pirani (CEP, Convectron™) Gauge.

This class of gauge operates like the Pirani gauge, including fast response, but has additional capability due to a special structure that takes advantage of and responds to convection cooling at higher pressures. This allows the response to be extended over a wider range, from lower limit of about 0.1 micron (1×10^{-4} torr) to an upper limit of atmospheric pressure.

In the molecular flow region (below approximately 2 torr), a gas species correction factor similar to TC and Pirani gauges applies, In the turbulent flow region (above 2 torr), the response to gas species other than the air/nitrogen becomes quite non-linear, with lighter molecules giving substantially higher, non-linear indicated readings than the true pressure and heavier molecules giving substantially lower, non-linear readings than the true pressure.

Since this type of gauge depends on gas convection for measuring pressures above a few torr, the gauge should be mounted with its long axis horizontal.

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