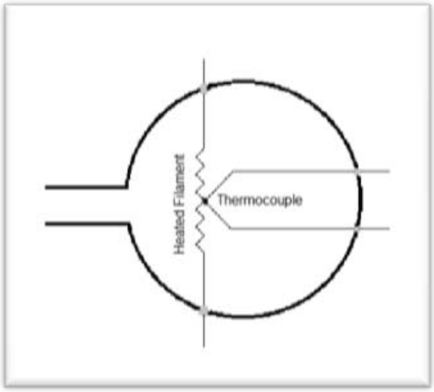
THERMAL VACUUM GAUGES

THERMOCOUPLE
PIRANI
CONVECTION ENHANCED PIRANI



BASIC DIAGRAM

BASIC ELEMENTS OF ALL THERMAL GAUGES

Envelope connected to the Vacuum System
Heated Filament
Thermocouple Sensor

- TC Sensor on Heated Filament
- Reference Temperature is Outside Gauge Envelope (Ambient Room Temperature)
- Voltage between leads increases with increasing sensor temperature
- Gas Density (Pressure) Conducts Heat away from the filament
- High Pressure/High Density/Poor Vacuum Causes High Heat Removal (Cooling)
- Low Pressure/Low Density/Good Vacuum Causes Low Heat Removal
- 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). See next page.
- 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.
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CAUTION: Since all Thermal Gauges utilize a heated filament, there is danger of explosion if exposed to combustible gases, especially at high pressures.

Three types of Thermal Gauges are in common use:

1. THERMOCOUPLE (TC) GAUGE SPECIFICS

- Thermocouple sensor measures filament temperature
- Power to heated filament is kept constant
- At high pressures, more filament cooling occurs, the filament temperature and TC sensor voltage drop
- As vacuum improves, gas density falls, and filament temperature rises.TC sensor voltage rises
- Thermocouple voltage inversely related to pressure
- Temperature changes, therefore pressure readings, are slow due to thermal mass of gauge parts
- Useful range: 10^{-4} torr to 2 torr (molecular flow region)

2. PIRANI GAUGE SPECIFICS

- Thermocouple measures filament temperature
- Power to heated filament is adjusted to keep temperature/TC reading constant
- At high pressures, power to the filament is high due to gas cooling
- As vacuum improves, gas density falls, power to the filament falls.
- Filament power is directly related to pressure
- Response time is faster due to constant temperature of gauge parts
- Useful range: 10^{-4} torr to 2 torr (molecular flow region)

3. CONVECTION INHANCED PIRANI (CEP, Convectron®) GAUGE SPECIFICS

- Electrical operation is like a Pirani Gauge
- Gauge Envelope-to-Filament spacing is reduced to extend convection cooling to higher pressures
- Useful range: 10^{-4} torr to 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.

Thermal Gauges - Thermocouple & Convection
Gas Species Correction Factors
For Pressures Below 1Torr

Gas	Factor
N_2/Air	1.0
Kr	2.2
Ar	1.7
Ne	1.4
He	1.1
O_2	1.0
CO_2	0.9
CH_4	0.7

Multiply the Indicated Pressure by the Gas Factor to Obtain the True Pressure

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