Gas Correction Curves for PG105 Gauges

It is important to understand that the pressure indicated by a PG105 convection-enhanced Pirani gauge depends on the type of gas. All PG105 convection-enhanced Pirani gauges are factory-calibrated and temperature-compensated for nitrogen (air). However the response of the gauge to other gases is very well characterized and, with the proper calibration data, it is possible to obtain accurate pressure measurements for other gases as well.

IGC100 controllers are factory-loaded with Nitrogen and Argon specific calibration curves compatible with all PG105 gauges, and direct pressure measurements are possible for both gases.

If you must measure the pressure of gases other than Nitrogen or Argon, use Gas Correction Curves, like figures I-1 and I-2 included in this application note, to convert "nitrogen equivalent pressure" readings into "actual pressure" readings for those gases.

Gas Correction Factors (relative to nitrogen equivalent readings) can also be used for pressure measurements below 1 Torr (See Table I-1)

PG105 users should generate their own conversion curves for gases, or mixtures of gases, not included in this application note. A calibrated, gas-independent, capacitance manometer is recommended as a transfer standard[1].

In This Application Note

Gas Correction Curves and Factors

Important

The conversion curves and factors listed in this application note only apply

1. when the pressure readings displayed by the controller are based on the nitrogen calibration curve (i.e. PG Cal Curve = N2 Curve)

2. the gauge tube is mounted with its axis horizontal.

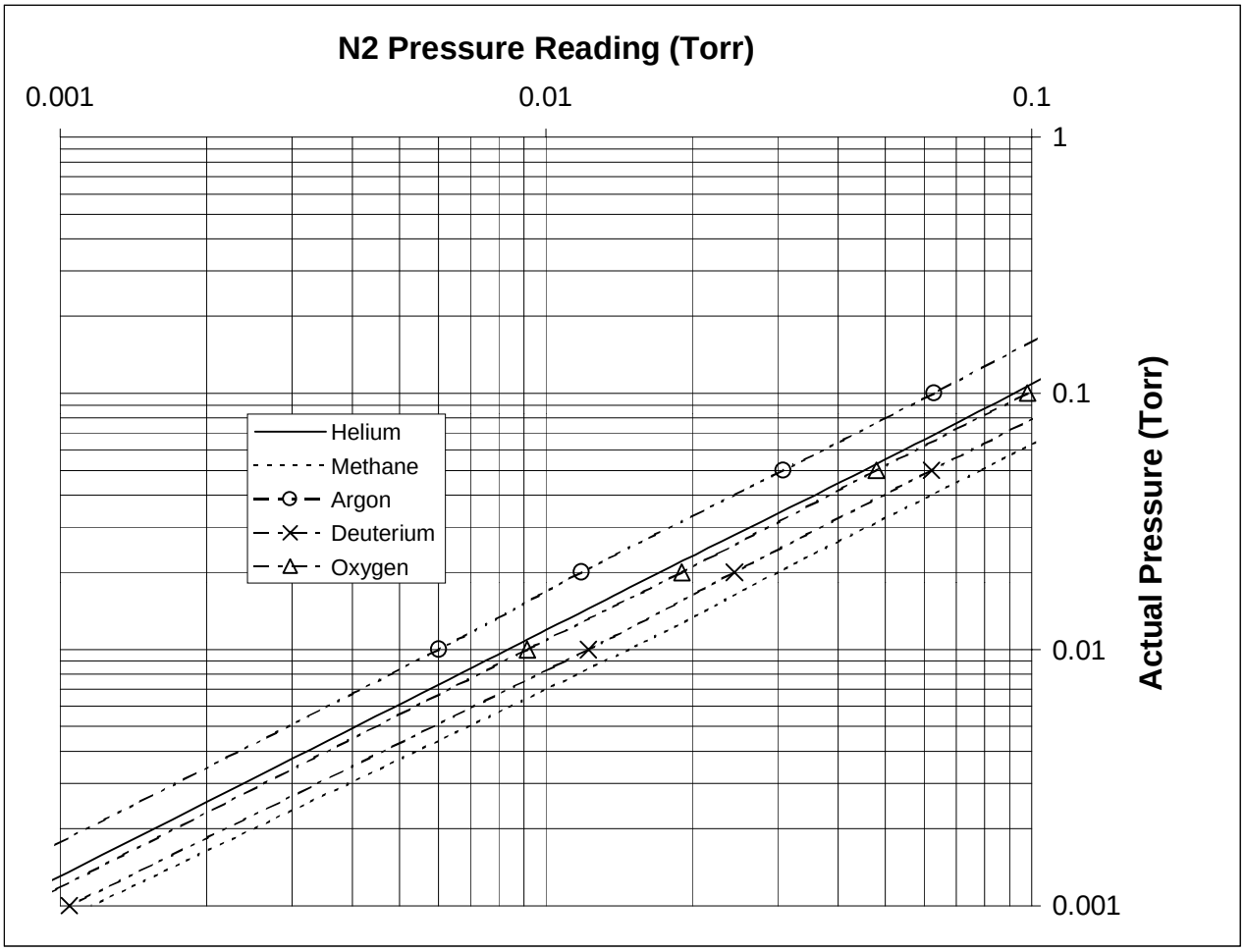

Figure I-1. PG105 Gauge Indicated Pressure (N_2 equivalent) vs. Actual Pressure Curve: 10^{-3} to 10^{-1} Torr.

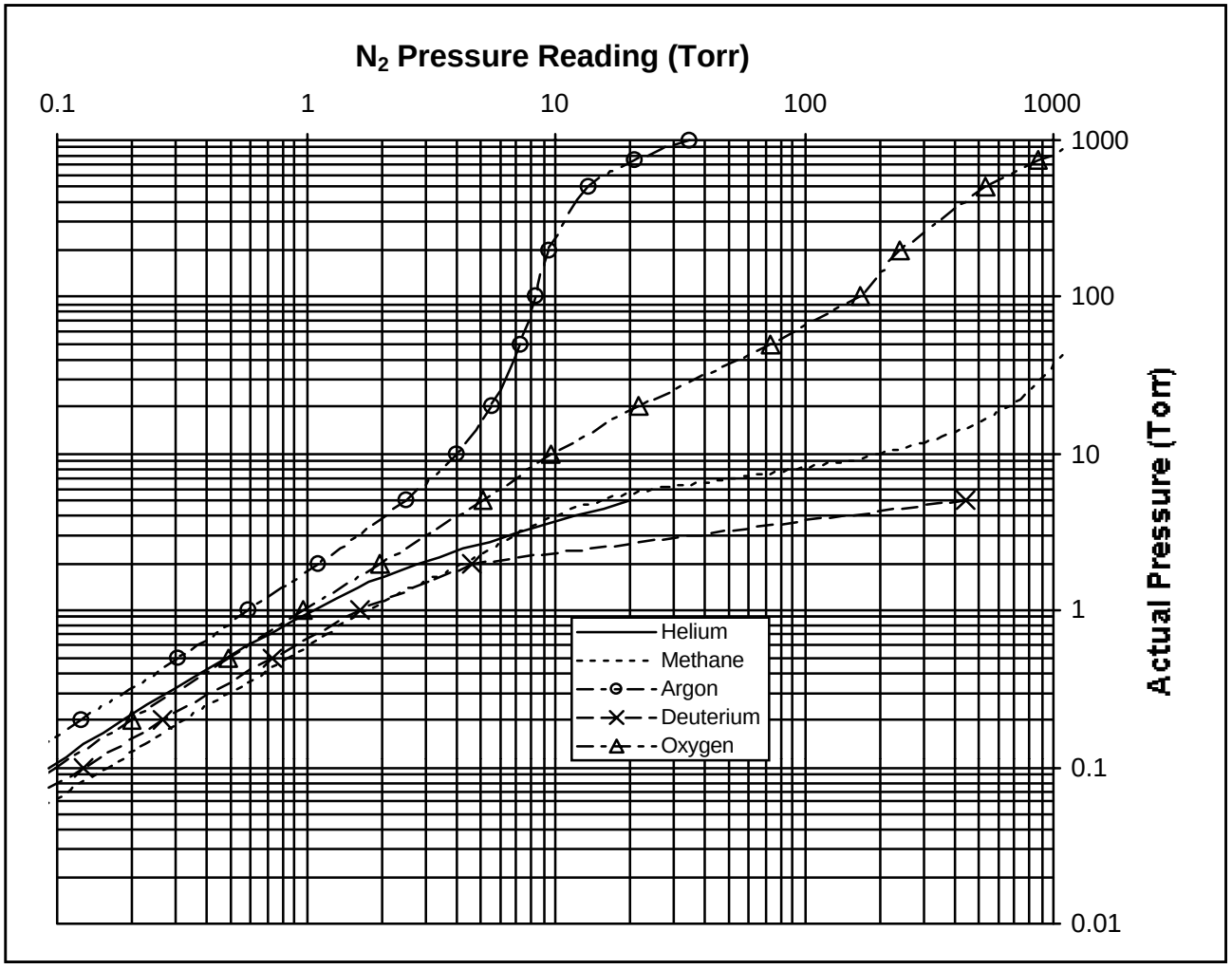

Figure I-2. PG105 Gauge Indicated Pressure (N2 equivalent) vs. Actual Pressure Curve: 10^{-1} to 1000 Torr. Use only when gauge axis is horizontal.

Nominal Gas Correction Factors for Figures I-1 and I-2.

Actual pressure = N_2 equivalent reading x K_g

(Use for pressures below 1 Torr only!)

Gas	K_g
Ar	1.59
He	1.10
Oxygen	1.03
Nitrogen	1.00
Deuterium	0.79
Methane	0.63

Overpressure risks

DANGER!

Using a PG105 convection gauge to backfill to atmospheric pressure should be avoided unless the gas-specific calibration curve for the backfilled gas is used to calculate and display pressures.

A serious danger can arise if the calibration data for one gas is applied without correction to measure pressures for a different gas (or gases) at or above atmospheric pressure. Argon provides an excellent example of how things can go very wrong. Applying the nitrogen calibration data to measure argon pressures provides a "nitrogen equivalent" reading of only ≈22 Torr when the gauge is exposed to an atmosphere of Argon gas (see Figure I-2). The chamber could be seriously pressurized while the gauge controller continues to display <100 Torr of nitrogen equivalent pressure. An oblivious operator, looking for a 760 Torr pressure reading, might continue to increase the gas pressure leading to the possibility of a dangerous explosion. Reports of accidents caused by this effect have appeared in the vacuum literature[2]. Accidents such as these can occur only if a thermal conductivity gauge is used to measure pressures at the upper end of the range where the calibrations for different gases diverge widely. This is the one reason why many vacuum practitioners reserve their convection gauges for measuring foreline and roughing line pressures, or *moderate* backfill pressures only!

At pressures below a few Torr the danger of using the nitrogen (or argon) calibration to measure the pressures of an uncalibrated gas (or gases) disappears. The only problem left is the inaccuracy of the readings. However, it is generally possible to correct pressure readings for uncalibrated gases using lookup tables, conversion curves and even simple correction factors .

TIP

With systems that could be potentially backfilled to excessive pressures by failure of gauges or regulator valves the inclusion of a pressure relief valve or burst disk is the safest way to avoid over pressurization!

References

[1] Consult R. E. Ellefson and A.P. Miller, “Recommended practice for calibrating vacuum gauges of the thermal conductivity type”, J. Vac. Sci. Technol. A 18(5) (2000) 2568, for information on thermal gauge calibration and accuracy.

[2] R. Chapman and J. P. Hobson, J. Vac. Sci. Technol. 16 (1979) 965, D. G. Bills, J. Vac. Sci. Technol. 16 (1979) 2109.