

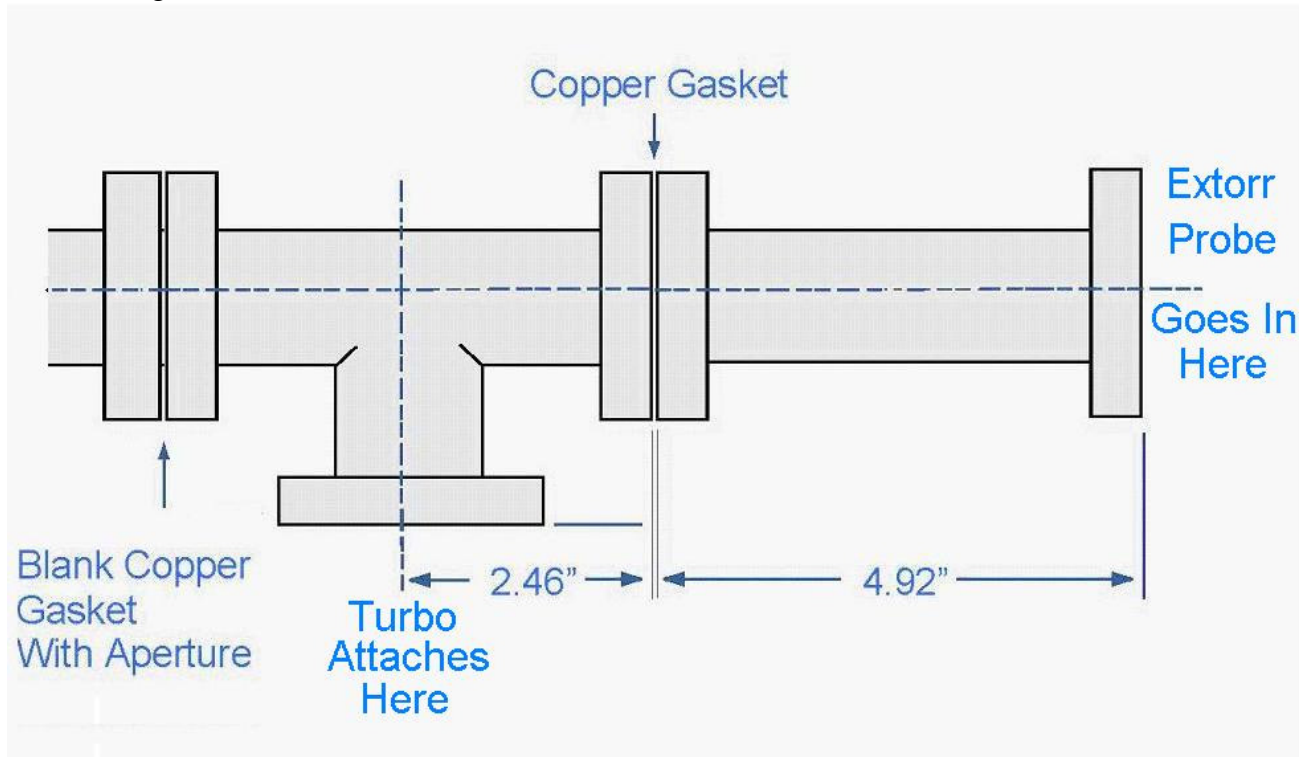
## Application Note Number 5: Pressure Reduction Systems I

**Abstract:** The vacuum environment for partial pressure measurements should be no greater than  $10^{-5}$  torr. If the process requires pressures orders of magnitude above this, a pressure reduction system is required. This note describes the simplest of pressure reduction systems.

Although the Extorr quadrupole analyzer may be operated somewhat above  $10^{-4}$  torr, the peaks seen are derived not only from single electron impact but also from ion-molecule charge exchange and scattering. The information derived from these peaks, although it may be qualitatively useful, is so dependent on gas matrix conditions that it yields limited quantitative information.

If it is desired to make measurements on the gases in a process operated at pressures above  $10^{-5}$  torr, a pressure reduction system is required.

An example of the simple pressure reduction vacuum chamber which can house the Extorr probe is shown in figure 1 below.



**Figure 1 Pressure Reduction Plumbing**

The vacuum system consists of a 2 ¾ inch CF vacuum nipple and T. These parts are produced by computer controlled equipment and have very tight tolerances. Most vacuum equipment suppliers carry these and your total bill will be less than \$250. The turbo, of course will be more expensive. A small 50 l/s turbo, necked to a 2 ¾ inch CF flange, will work well here. A roughing pump will be required to back the turbo. The actual pumping on the probe will be about 30 l/s.

The gas restriction into this chamber is a hole in a blank copper gasket. This gasket is like the familiar CF sealing gaskets except the center is not cut out. The gasket will seal the pressure reduction chamber to the process chamber.

We must now calculate the size of an aperture to be placed into the copper gasket. If we want the pressure on the probe to be no greater than  $10^{-5}$  torr, the inlet from the users chamber should not allow more than  $30 \times 10^{-5}$  torr l/s. The rule of thumb is that air (mostly nitrogen) will hit a surface at the rate of  $11.6$  l/s-cm<sup>2</sup>. Though strictly correct only for the molecular flow pressure region, this calculation works fairly well for pressures up to an atmosphere. Equating flow into the sampling chamber with flow out of the chamber, the area and diameter of a circular hole may be calculated.

**Example: What aperture would be required to measure the gases from a process working at 10 millitorr?**

Equating flow in to flow out we get

$$11.6 \text{ l/s} \times 10^{-2} \text{ torr} \times A = 30 \text{ l/s} \times 10^{-5} \text{ torr}, \text{ where } A \text{ is the aperture area in cm}^2.$$

Solving for A we get  $A = 2.6 \times 10^{-3}$  cm<sup>2</sup>. Multiplying this by 4 and dividing by pi and then taking the square root gives an aperture diameter of about 0.6 mm.

In the example above, this hole is probably large enough to be drilled by hand. Smaller holes may be drilled using a laser.

The advantages to such a system are that you can actually make measurements of gases at higher pressure. The system response is very rapid.

When the process system is pumped down to its base pressure, the sampling system will be dominated by gases coming from the sampling system not the process chamber. High conductance plumbing could be added to the sampling system but the added cost could rival the cost of a second RGA.

The question of can you see gases which are in the few parts per million range is always asked. The answer is, of course, yes and no.

If you are looking for a gas which produces an ion at a mass to charge ratio not shared by typical background gases, the answer is probably yes. If you are looking for gases which normally come from the chamber background or from the ionizer filament such as CO, CO<sub>2</sub>, or water vapor, the answer is no.