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Application Note Number 21:
What is the Difference Between a Helium Leak Detector and an RGA?

Abstract: It is often said that a Residual Gas Analyzer (RGA) may be used as a detector for leaks in a vacuum system. This note explains the difference between a helium leak detector and "a detector for leaks in a vacuum system".

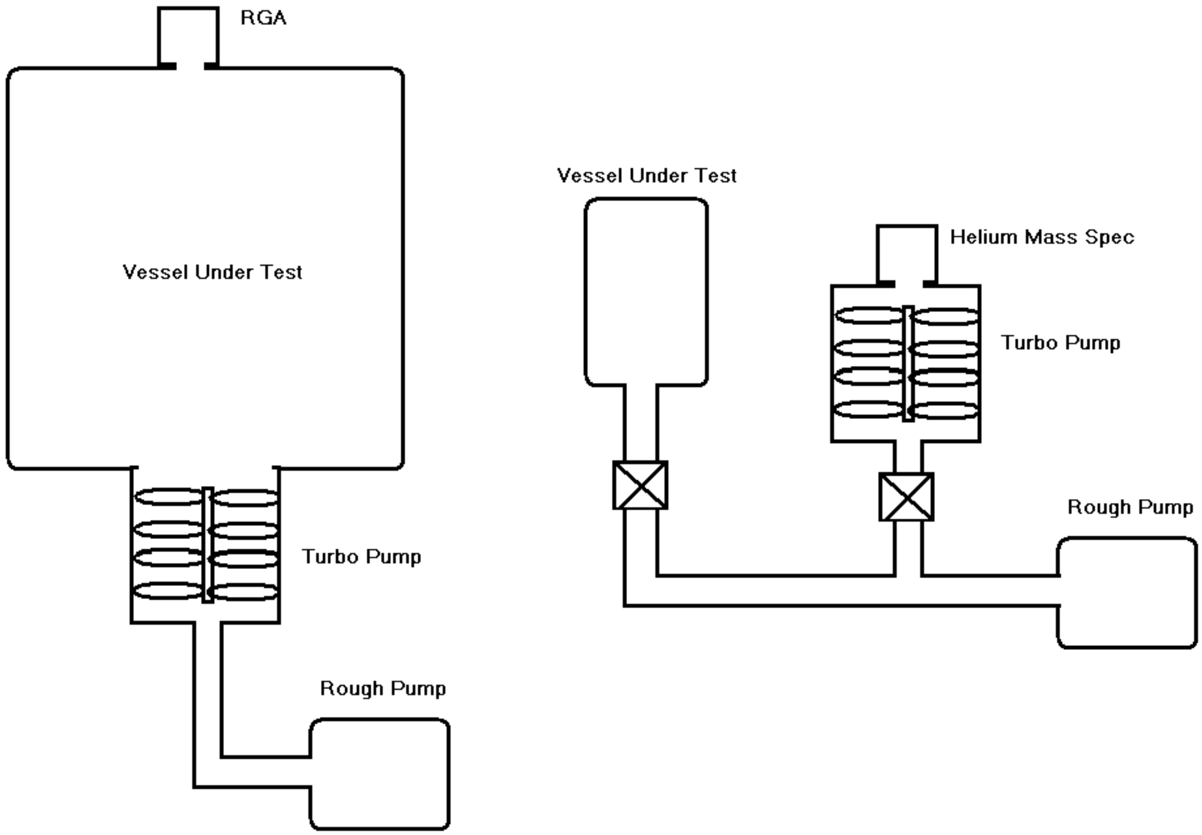
A typical RGA requires a pressure of 10^{-4} Torr or lower to operate. Any leak that prevents the chamber from reaching that pressure must be found using another vacuum gauge. The Extorr XT Series RGA, with its built in Pirani and B /A ion gauge can give leak information at pressures many orders of magnitude above where the typical RGA will operate.

A large leak will usually produce a high pitched whistle or hissing sound as the air rushes into the chamber. If the noise cannot be heard, a large leak may be found using the Extorr XT Series built in Pirani gauge with a leak tracing gas such as helium, argon, or freon. The Pirani will respond rapidly when the leak tracing gas enters the chamber at the site of the leak. When the pressure is below 10^{-2} Torr, the Extorr XT Series built in B / A ion gauge can perform the same function.

If the pressure is below 10^{-4} Torr, the RGA may be used to generate a mass spectrum of the background gasses. If N_2 at 28 amu and O_2 at 32 amu are shown at a ratio of 4:1 and they remain at a constant intensity over time, an air leak is likely. A true air leak will also show argon at 40 amu that is about 1% of the 28 amu peak. If a leak is present, the RGA can be used to find its location. The RGA is set to monitor the intensity of a leak tracing gas as it is sprayed on the outside of the vacuum chamber. The intensity will increase as the spray passes over the site of the leak and then will decrease as it is moved away. The size of the leak determines the intensity of the leak detect gas peak and the RGA displays the results in partial pressure (units of Torr, Pascal, or Ion Current). Since the RGA is a mass spectrometer, it is not limited to using only one leak tracing gas. Although helium is probably the most common leak tracing gas, argon or some volatile liquid could be used.

As well as the Extorr XT Series RGA works for solving certain problems, the helium leak detector will work better for others. Both devices have their place and their applications rarely overlap. A helium leak detector has a self-contained vacuum system and will not require the chamber to be checked to have a vacuum pump on it. In fact such a pump would interfere with the leak detection. The chamber under test is pumped out through the roughing pump of the helium leak detector. This roughing pump also backs the turbomolecular pump which evacuates the helium mass spectrometer. After the chamber under test is pumped to a rough vacuum, helium is sprayed on the outside. If helium makes it through a leak into the vacuum, the helium will move through the roughing lines and diffuse "backward" through the spinning turbo blades to be measured by the helium mass spectrometer. The size of the leak determines the amount of helium that is detected and the results are given as a leak rate in atmosphere-cc/s. The leak detector usually has an audio signal as well as a visual display to indicate the increasing helium peak intensity. The location of a leak may be traced in the same way as with the RGA by passing a helium spray over the leak. Unlike the RGA, the leak detector must use helium as the leak tracing gas.

The difference between the RGA and the helium leak detector are summarized in the figure below.



If a vacuum system that contains an Extorr XT Series RGA has a helium leak rate of 10^{-8} atm-cc/s, what is the measured partial pressure of helium? The answer depends on the geometry and pumping rate of the vacuum system. For a simple geometry as shown above with a 100 liter/second turbomolecular pump, and using mass flow in is equal to mass flow out, we get 100 l/s times the helium partial pressure equals 10^{-8} atm-cc/s. An atmosphere-cc equals 0.76 Torr-liter. Solving for pressure gives 7.6×10^{-11} Torr.

Next, given a sealed, evacuated 10 liter vacuum system containing an Extorr XT Series RGA, how long must you wait before a 10^{-8} atmosphere–cc/s helium leak would produce a 10^{-8} Torr peak? An atmosphere-cc equals 0.76 Torr-liter. So if this amount of helium goes into a 10 liter volume, the helium pressure would increase by 7.6×10^{-10} Torr every second. It takes about 13 seconds to produce a 10^{-8} Torr peak. For this to be useful, the base pressure of the vacuum system must be low enough for RGA operation and must remain low enough during those 13 seconds without pumping. So a good UHV pump with a gate valve and a system that has either been pumped for many hours, or has been baked, is required.