TECHNICAL NOTE

Residual Gas Analyzers for Leak Detection

Residual Gas Analyzers (RGAs) have been used in vacuum research applications for 25 years. Their role has changed in the last 10 years, as they have moved from purely a research instrument to a production tool. As a production tool, the RGA can increase productivity, improve product yield, increase throughput and reduce costs, all of which ultimately increases profits.

However, it is up to the user to determine how the tool can best meet the needs of a specific application. INFICON, as an RGA manufacturer, can help users determine the most cost-effective easy to use RGAs. This Tech Note is concerned with how the RGA can be used for leak detection.

Many production vacuum systems work at two distinct pressure ranges. The first, typically called base pressure, is a method of cleaning the vacuum chamber and its parts before the production process begins. If the base pressure of the vacuum system is less than $1E^{-4}$ Torr, a standard RGA can be mounted to the vacuum system to monitor the base pressure. The second pressure range, process pressure, is typically several decades higher and is created by adding various gases used in the particular process.

Several methods can be used to determine if a tool has a leak. The first and simplest is to use an ion gauge to check if the background pressure level in the chamber is higher than normal. The problem with this method is that if there is a pressure increase, there is no indication of what may be causing it. A second method that allows the user to have access to a lot more information is to use a residual gas analyzer. RGAs take up minimal equipment space and allow users to collect atomic mass data that can be interpreted as different gas species in a system.

COMMON METHODS TO DETECT LEAKS

An RGA can be used as a leak detector since it can detect helium as well as many other gases. One way to use an RGA is to mount it directly on the vacuum system and spray helium around questionable joints or welds. If there is a leak, the helium will enter the system via the leak and the RGA will detect it in the vacuum system. The helium gas (mass 4) will be seen and can be tracked over time. The leak rate is determined by the size of the leak and the vacuum system's pumping speed. Figure 1 shows how a set alarm level has been exceeded by a large leak.

Most RGA software packages allow for audible indication of changes in the helium level, so that users don't have to continually look at the monitor.

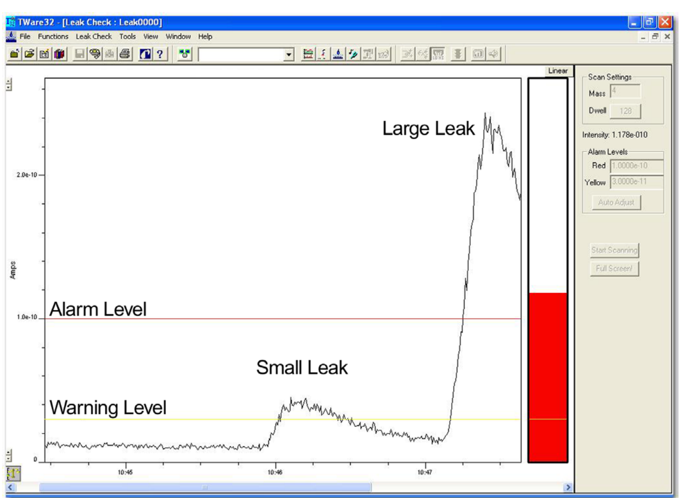

Figure 1: Alarm Level Exceeded During Helium Leak Detection

Another helium leak detection method is to sample the outside of a helium-filled part. The RGA system for this requires a differential pumping system with capillary inlet. This capillary "sniffer" is used to sample at the welds and fittings for helium leaks.

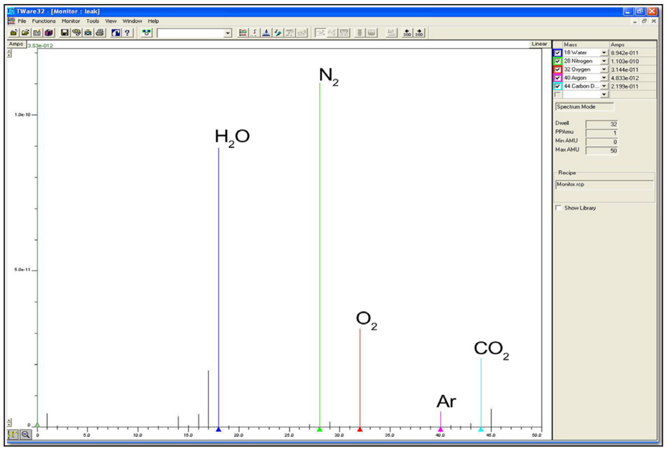

Figure 2: Air and Water Contamination Spectra

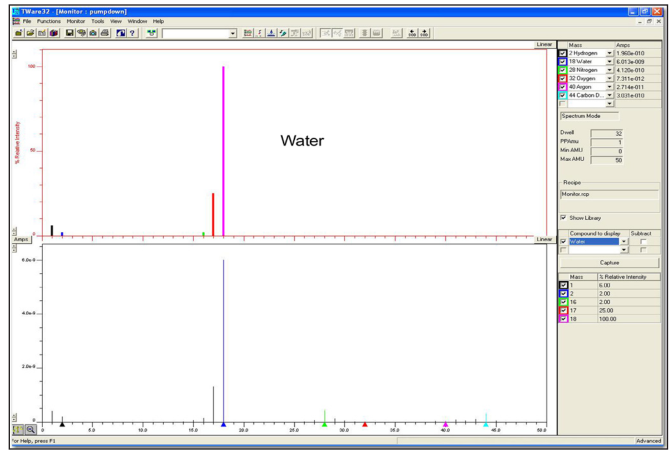

Figure 3: Water Library File Over Current Data

AIR LEAK DETECTION

An RGA also can be used to detect leaks immediately. The most common is an air leak from the fittings or welds of a vacuum chamber. Air leaks can be very serious because many processes are adversely affected by excess nitrogen, oxygen and water. Air leaks also raise the background pressure of the vacuum chamber. The data from an RGA allows users to establish the process' normal gas "signature," and a change in it will alert the user to possible contamination as the cause. An example of this would be a new 4:1 ratio of nitrogen (mass 28) to oxygen (mass 32), signaling air contamination, or a significant increase in water (mass 18) without an increase in argon levels (Figure 2).

VIRTUAL LEAK DETECTION

"Sticky" compounds such as water or alcohol give rise to another type of problem, the virtual leak. When these compounds are accidentally introduced into a system, they may stay there for long periods of time without a bakeout and raise the background levels of a chamber.

"Virtual" leaks can be caused by trapped volumes of water vapor or air within the inner surfaces of the vacuum weldments or dead-end areas. These types of leaks are almost impossible to detect without using an RGA for identifying the type of virtual leak. In this case, all attempts at helium leak checking will be unsuccessful because there is no structural problem.

When cleaned but insufficiently dried parts are brought into the vacuum chamber with excess water or other solvents on them, they are a common source of these virtual leaks. Users may suspect the presence of these compounds and most RGA software packages have built-in spectrum libraries for assisting in the identification of such compounds. Figure 3 shows how an RGA can display a library file such as water on top of current data, allowing the user to confirm the presence of a specific contaminant within the vacuum chamber.

The residual gas analyzer is an invaluable instrument for leak detection. In production environments, where downtime and bad yields mean lost dollars, a residual gas analyzer can quickly provide the information needed to avoid these problems and will pay for itself in the process. Because of its unique capability not only to alert the operator of a problem but to help in its solution, the RGA stands out from other types of *in situ* leak detectors.

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