INFICON

TECHNICAL NOTE

The Advantages and Disadvantages of a Mobile RGA Sampling System

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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 evolved 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. This Tech Note is concerned with the various advantages and disadvantages of using a mobile mounted RGA sampling system with differential pumping.

HOW AN RGA IS USED

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 process begins. If the base pressure of the vacuum system is less than $1Ex10^{-4}$ 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. Through a differential pumping system an RGA can monitor these processes and even wider ranges of pressures.

WHAT IS A MOBILE SAMPLING SYSTEM?

A mobile sampling system is normally a cart mounted pumping setup with a residual gas analyzer attached. The pumping setup consists of an inlet system mounted above a turbomolecular pump that is backed by a roughing pump. This pumping package is usually available with “wet” oil pumps or with “dry” oil-free pumps. The inlet setup is also available in different versions. The inlet can be setup to attach right to a vacuum chamber using a bellows or there is the option of adding an atmospheric sampler that uses a two stage pressure reduction scheme and a second pump. This differentially pumped system is used to reduce the pressure from the vacuum system to the mobile cart in order to maintain a proper operating pressure and ensure the safety of the RGA. Figure 1 shows an example of a mobile sampling system with both inlet systems installed. The user has a choice of a capillary “sniffer” or a fixed bellows attachment to the manual valve with an orifice installed inside.

ADVANTAGES OF A MOBILE SAMPLING SYSTEM

The advantages of a system, such as the one shown in Figure 1, include low cost, mobility, and a self-contained vacuum system with a built in residual gas analyzer capable of continuous sampling of most vacuum processes from two atmospheres down to $1x10^{-8}$ Torr. The largest benefit of a mobile sampling system is the money saved by not installing an RGA on every vacuum system. Instead of one RGA per chamber, the cart mounted RGA can be wheeled up and attached with bellows to a chamber for sampling. With the capability of sampling at atmosphere with the capillary inlet, the system can also be wheeled to any part of the building to check for problems.

Figure 1: Example of a Mobile Sampling System

The benefit of a differentially pumped continuous sampling capillary system is that its response time is quick (typically in the range of a few seconds). To the operator this means that there will be a quick notification of any problems within the sample.

DISADVANTAGES OF A MOBILE SAMPLING SYSTEM

Although there are advantages of a mobile sampling system there are also many disadvantages that the end user must be aware of. Foremost is the issue of detection limits. A system, similar to the one shown, is typically manufactured from off-the-shelf parts and can be oriented in different ways. Consequently, proper heating jackets are not always available. Without proper bakeout, the background in the vacuum system is so high that it is impossible to sample background in many modern cluster tool. Proper mobile systems are designed with restricted pumps in order to minimize mass discrimination. Improper bakeout and reduced pumping speed along with a system that utilizes an open ion source RGA means the detection limits of the customer's sample are usually never lower than 500-1000 parts per million. These systems also have an even higher residual water vapor level (up to 1%) due to the large surface areas associated with the system itself, the inlet and the connecting hardware.

CONNECTIONS

With the mobility of this RGA system comes the issue of connecting it to the tool. Whether it is a short connection nipple with limited surface area or a large bellows with large surface area, it will be at atmosphere and must be evacuated. Using the RGA system with its reduced pumping speed will not only be slow but make its detection limits even worse. Yet, the customer does not wish to pump out this trapped volume with their tool for fear of more contamination that the RGA is trying to detect in the first place.

RESPONSE AND CLEANUP

Another issue with the mobile system is with response and cleanup times. As the process pressures increase, the bellows connection to the tool can make the response times become ridiculously long. For example, a standard 3 foot length of bellows attached to a 1 Torr process would give a response time of over 45 seconds. When using a capillary style inlet the response times are much quicker, but this dual stage pressure reduction is usually reserved for sampling high pressures such as greater than 10 Torr.

Cleanup times associated with sampling "sticky" gases such as isopropyl alcohol, SO2, and HF (most chlorines and fluorines are sticky gases as well as water vapor) is also an issue with a mobile RGA system. The ionizing region of an open ion source RGA is exposed to the entire differentially pumped system that it is mounted to. Therefore, the sample must be completely pumped from all exposed surfaces before the residuals will vanish. Residual gases left in the system can be responsible for cross contamination of samples as well as the tools themselves.

HARDWARE

Lastly, there are hardware issues that are inherent to mobile RGA sampling systems. Besides the bellows connection to the tool, there are issues with supplying air and power. For more aggressive applications, such as chemical vapor deposition (CVD), dry nitrogen and exhaust connections are required. This means that every time the mobile system is moved to a new location, new compressed air, nitrogen, power and exhaust connections must be made.

APPLICATIONS

An RGA mounted on a mobile sampling system can be a very versatile piece of analysis equipment. A mobile sampling system can fill the role of a non-permanent troubleshooter that can move around the building and be attached to a system when a problem arises. Although there are a number of applications where the benefits of a mobile RGA system are inherent, the drawbacks of decreased detection limits, higher background levels, excessive response and cleanup times and utilities cannot be overlooked. It is important for the end user to be aware of both the advantages and disadvantages of a mobile sampling system so that they can best determine if this type of residual gas analyzer is right for them.

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