



MIRAN[®] SapphIRe Gas Analyzer

Applications in the Hospital Environment

INTRODUCTION

Versatility is one of the most important features to examine when deciding on an analytical tool for measuring gases in hospital environments. There are a variety of applications in the hospital that require gas monitoring. However, these applications are not simple due to the low limits of detection and interfering gases. We will examine: Medical Air Purity Testing, Anesthetic Leak Detection, Waste Anesthetic Gases, Ethylene Oxide, Formaldehyde, and Anesthetic Cart Calibration. We will also touch on several other applications that can be performed with one system, the MIRAN SapphIRe Series of Portable Ambient Air Analyzers.

Any of the instruments in the SapphIRe Series is able to detect the gases mentioned in the hospital applications, but to better understand which instrument is best suited for you requires examination of the features of the system.

SAPPHIRE 5 ANALYZER

This unit is factory calibrated for one user-defined multi-gas application and has User Library space available for 9 more multi-gas applications and for 10 single gas calibrations.

SAPPHIRE 30 AND SAPPHIRE 30E ANALYZERS

These units are also factory calibrated for one user-defined multi-gas application but are also calibrated for 30 single gas analyses. The User Library has a total of 19 additional spaces for single and multi-gas custom calibrations.

SAPPHIRE 100 AND SAPPHIRE 100E ANALYZERS

These units are calibrated for one user-defined multi-gas application but are also calibrated for over 100 single gas analyses. The User Library has a total of 19 additional spaces for single and multi-gas custom calibrations.

VERSATILITY

The MIRAN SapphIRe Analyzers are Infrared Spectrophotometers which provide wavelength versatility required to detect each gas. Any of the instruments in the SapphIRe series is able to detect the gases found in hospital applications. The number of preset calibrations that you may require is all that differentiates one unit from the next. The ability of the analyzer to be field calibrated is an enormous advantage.

The SapphIRe Analyzer also has the ability to perform spectral scans to aid in the identification of unknown gases. This feature is valuable during hazardous gas release episodes.

APPLICATIONS

Medical Air Purity Testing

Medical Air Purity Testing requires that piping, supplying hospital rooms, be checked for contaminants. Medical Air is typically made on site by drawing outside air through a compressor and piping it to the room. NFPA 99 requires that the point immediately after the compressor be tested for the following compounds (Table 1):

Compound	Limit (ppm)	Location
Carbon Monoxide	25	All points
Carbon Dioxide	500	All points
Hydrocarbons (methane)	25	All points
Hydrocarbons (chloroform)	2	All points compared to 1 st point after compressor

Table 1

Additionally, points downstream require testing for these components. The number of points in a hospital to be tested depends on several factors but it is common to have to test a minimum of five points and often up to several dozen.

A multi-gas application can be efficiently performed by the SapphIRe Analyzer by measuring each of the gases at the defined wavelengths. This application is relatively simple since the gases do not have interference from one another.

Waste Anesthetic Gases

Routine maintenance of anesthetic delivery systems is a critical test to prevent these agents from escaping into the work area. Detection of several halogenated agents in a mixture would normally be impossible due to their similar infrared spectra. However, with the SapphIRe analyzers, on-board algorithms allow for correction of these interferences. By measuring these gases simultaneously, the analyzer can separate the signals. Each of these gases can, of course, be measured in a single gas fashion but if a second or third agent is also present, the analyzer is not able to discern which agent is leaking.

The gases that are typically measured are shown in Table 2

Gas	Exposure Limit (ppm)	Calibration Range (ppm)
Enflurane	2	0-10
Sevoflurane	2	0-10
Desflurane	2	0-10
Halothane	2	0-10
Nitrous Oxide	25	0-100

Table 2

These gases may be present alone or in combination, depending upon the leakage of the system. Table 3 shows the efficiency and accuracy of the application when various combinations of gases are present at various concentrations.

ETHYLENE OXIDE

Ethylene Oxide (ETO) has long been perhaps the most critical gas measurement a hospital faces. Because of the large volumes used and the toxicity, its detection is critical. Without an instrument that can perform interference compensation, detection of ETO is difficult. Typically, ETO is present in Central Services areas with Isopropyl Alcohol (IPA) and Freon 124 (F124). As can be seen in Figure 1, ETO has interference from both these other chemicals.

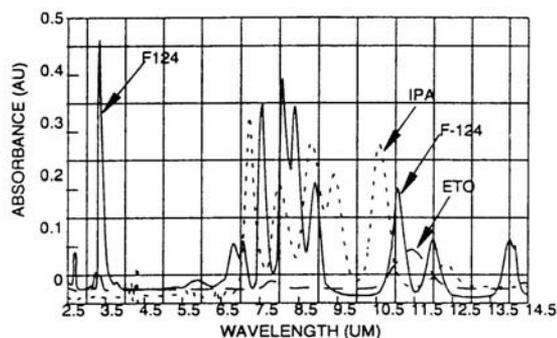


Figure 1

At fairly low levels, under 10 ppm, detection of ETO in the presence of these other chemicals is fairly simple. However, if one chemical is overwhelming the mixture, the algorithm may fail to completely and accurately identify the correct concentration. In these situations, a measured concentration that is slightly inaccurate is acceptable since the SapphIRe analyzer is identifying a major leak problem.

The SapphIRe can be used for several purposes in these applications:

- Short term monitoring for compliance purposes - 29 CFR 1910.1047
- Leak detection around doors and plumbing fittings
- Teaching tool to show technicians good work habits

FORMALDEHYDE

Formaldehyde is present primarily in histology and pathology locations. Since Formaldehyde preparations are made with Methanol, identification of Formaldehyde can be difficult. However, with the multi-gas application benefits of the SapphIRe analyzers, interference problems are eliminated. The primary wavelength for detection of Formaldehyde is 3.6 microns as seen from the spectral overlay in Figure 2. Methanol also overlaps this peak, but since Methanol also has an absorbance peak at 9.8 microns, the interference compensation is simple.

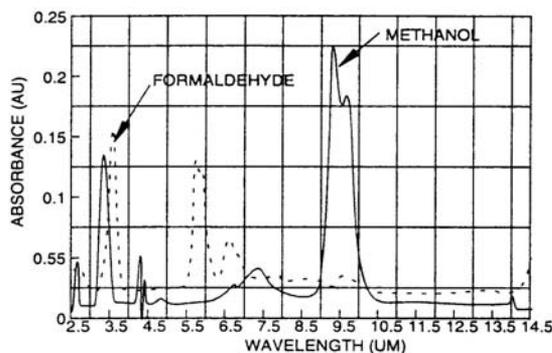


Figure 2

Actual Gas Concentration					Measured Gas Concentration				
Desflurane	Isoflurane	Sevoflurane	Sevoflurane	Nitrous Oxide	Desflurane	Isoflurane	Sevoflurane	Sevoflurane	Nitrous Oxide
5.2	0.0	0.0	2.8	0.0	4.5	0.0	0.0	3.0	0.0
5.2	7.0	0.0	2.8	0.0	5.1	6.8	-0.2	3.2	0.0
0.0	4.7	4.5	2.8	0.0	0.6	4.3	4.3	2.5	0.0
2.6	0.0	2.3	2.8	0.0	2.2	0.1	2.7	2.8	0.0
7.8	4.7	0.0	0.0	0.0	5.7	4.8	0.0	0.0	0.0
2.8	7.0	2.3	2.8	0.0	2.8	6.6	2.6	3.0	0.0

Table 3

ANESTHETIC CART CALIBRATION

Anesthetic carts are routinely checked for delivery concentrations in the field. Since the SapphIRe analyzers have significant wavelength and pathlength selectivity, measuring percent levels of anesthetic agents is simple. The analysis is performed by flowing the agent through the SapphIRe analyzer at the standard delivery rate of 5 liters/minute for about 2-3 minutes. Table 4 shows the range of calibration for these gases.

The analysis can be performed as a series of single gas measurements or as a combined application where several agents are measured simultaneously. Simultaneous measurement of these gases can be important. For example, if you are checking the delivery of Halothane, you would expect the Halothane measurement to be reading the correct output concentration and all the other agents is being performed, you can verify that the vaporizers are actually filled with the correct agent. For example, accidentally placing Isoflurane in a Halothane vaporizer would be detected immediately.

Agent	Concentration Range
Desflurane	0-20%
Sevoflurane	0.7%
Halothane	0.7%
Enflurane	0.7%
Isoflurane	0.7%

Table 4

OTHER APPLICATIONS

Room Air Exchange

Room Air Exchange analysis are performed quite easily by the SapphIRe analyzer by using a Tracer Gas such as SF₆ or N₂O. These gases are introduced into a closed room with the ventilation off. After the ventilation system is activated, the concentration of the tracer gas is then measured every minute. A plot of the natural logarithm of the concentration versus time reveals the Room Air Exchange Rate in Changes/Hour. See LAD 001-037 for a more complete discussion of the application.

Xylene, Methyl Methacrylate, Refrigerants

These gases and solvents are present in various areas of hospitals and can be effectively detected in a single gas mode. The reasoning is that these gases or solvents are typically present without any other gases in the area.

SYSTEM CONFIGURATIONS

System Configuration #1

Gas Application	SapphIRe 5 Analyzer	Cost	SapphIRe 30 Analyzer	Cost
1. Medical Air	Factory Set		Factory Set	
2. Waste Anesthetic	User Library		User Library	
3. ETO/F-124/IPA	User Library		User Library	
4. Formaldehyde/MeOH	User Library		User Library	
Tracer Gas (SF6)	User Library		Fixed Library	N/C
Xylene	User Library		Fixed Library	N/C
Methyl Methacrylate	User Library		Fixed Library	N/C
Refrigerants	User Library		Fixed Library	N/C
	Total Cost		Total Cost	

Table 5

In this configuration, the user has chosen to treat Applications 1-4 as multi-gas analyses to avoid interference problems. All other applications are single gas applications. In the above system configuration, the cost for installing the multi-gas applications is the same for both units (up to 4 per unit). The only difference in cost becomes the cost to install the single gas applications in the User Library for the SapphIRe 5 Analyzer.

System Configuration #2

Gas Application	SapphIRe 5 Analyzer	Cost	SapphIRe 30 Analyzer	Cost
Medical Air	Factory Set		Factory Set	
Halothane	User Library		User Library	
Isoflurane	User Library		User Library	
Desflurane	User Library		User Library	
Sevoflurane	User Library		Fixed Library	N/C
Enflurane	User Library		Fixed Library	N/C
Nitrous Oxide	User Library		Fixed Library	N/C
ETO	User Library		Fixed Library	N/C
User Library	User Library		Fixed Library	N/C
SF6	User Library		Fixed Library	N/C
Xylene	User Library		Fixed Library	N/C
Methyl Methacrylate	No Space		Fixed Library	N/C
Refrigerants	No Space		Fixed Library	N/C
High Conc. Anesthetics (5)	No Space		User Library	

In this configuration, the user is only interested in treating most applications as a single gas analysis. The choice is clear. The SapphIRe 30 Analyzer is the most cost effective method for performing the analyses.

CONCLUSION

When trying to decide on an analytical instrument for the detection of gases in the hospital environment, versatility is a key component in the decision making process. The SapphIRE Series of Portable Ambient Air Analyzers is perhaps the most cost effective and versatile instrument ever developed. Regardless of which SapphIRE unit you choose, one will fit your budget now and in the future. With the capability of upgrading to any version in the entire series, you will never look back on your decision as incorrect.

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