

APPLICATION NOTE: Simultaneous measurement of Waste Anesthetic Gases: Nitrous Oxide, Sevoflurane, Isoflurane, Enflurane, Halothane, Desflurane, Methoxyflurane

Waste Anesthetic Gas (WAG) concentrations in Operating and Recovery Rooms continually expose healthcare workers to their own health risks. A routine monitoring program can easily close this gap and provide complete assurance to the healthcare workers that their workplace environment and air quality carries no health risk to themselves and colleagues.

For years, many healthcare facilities have vigilantly undertaken routine monitoring using instruments primarily focused on detection of Nitrous Oxide (N₂O) assuming that if the N₂O gas concentrations were below NIOSH guidelines then other WAG's such as Sevoflurane, Isoflurane, Enflurane, Halothane, and Desflurane were also within acceptable levels.

Generally either the testing instrument was limited to monitoring just one gas (N₂O) or it was excessively time consuming to monitor each gas separately. The measurement technique typically used and cited under NIOSH Method 6600 was an infrared spectrophotometer, however since this paper was written in 1984 and updated in 1994 major advances in monitoring technologies have occurred.

Gasmeter Technologies' new Dx-4030 Gas Analyzer can measure 15 gases simultaneously using Fourier Transform Infrared technology (FTIR).

An FTIR analyzer detects gaseous compounds by their absorbance of infrared radiation. Because each molecular structure has a unique combination of atoms, each produces a unique infrared spectrum. From this, identification (Qualitative analysis) and analysis (Quantitative measurement) of the gaseous compounds is possible.

The Gasmeter Dx-4030 FTIR gas analyzer measures a complete infrared spectrum (a measurement of the infrared light absorbed by molecules inside the sample gas cell) 10 times per second.



Fig. 1. Gasmeter Dx-4030 FTIR gas analyzer.



Fig. 2. Gasmeter Dx – 4030 in use at an operating room with back-pack.

Multiple spectra are co-added together according to selected measurement time (improving signal-to-noise ratio). The actual concentrations of gases are calculated from the resulting sample spectrum using patented modified Classical Least Squares analysis algorithm and results are displayed on the screen of the PDA on Calcmet Lite software. In addition to concentration (in ppm, mg/Nm³ or vol-%), Calcmet Lite will also show a quality assurance value for each gas, the so-called residual. If the residual is low, a green status is displayed for the measured gas providing the user with assurance that no false identification of the measured gas has occurred. Similarly, a warning is given when the air sample contains a gas not included in the current analysis library. The user has the option to save this sample spectrum and then transfer it to a laptop or PC running the Calcmet Pro - software and identify this unknown gas by comparing the spectra against a spectrum library of up to 250 common ambient air gases.

One additional benefit of Gasmeter Dx-4030's FTIR measurement technology is the inherent calibration stability. The Gasmeter Dx-4030 performs a wavelength validation with every measurement using an internal high precision Helium Neon – laser. What this means in practice that there is no need for any span calibrations.

The Dx-4030 Gas Analyzer includes a library of 15 gases as standard. One of the standard libraries consists of typical gases encountered in healthcare workplace (see Table 1). An internal sample pump actively samples room air with all 15 gas concentrations displayed and logged on a PDA (Personal Digital Assistant) after just seconds from starting your gas monitoring.

Gas	CAS #	Range (ppm)	Detection Limit
Desflurane	57041-67-5	0 – 20	0.1
Sevoflurane	28523-86-6	0 – 20	0.1
Isoflurane	26675-46-7	0 – 20	
Halothane	151-67-7	0 – 20	0.1
Nitrous Oxide	10024-97-2	0 - 200	0.2
Enflurane	13838-16-9	0 – 20	0.1
Methoxyflurane	76-38-0	0 - 20	
Other common Hospital Gases			
p-Xylene	106-42-3	0 - 250	0.8
Formaldehyde	50-00-0	0 – 10	
Methanol	67-56-1	0 – 500	0.5
Ambient Air Gases			
Carbon Dioxide	124-38-9	0 – 2,000	
Carbon Monoxide	630-08-0	0 - 50	
Methane	74-82-8	0 – 100	
Water Vapour	7732-18-5	0 – 3%	

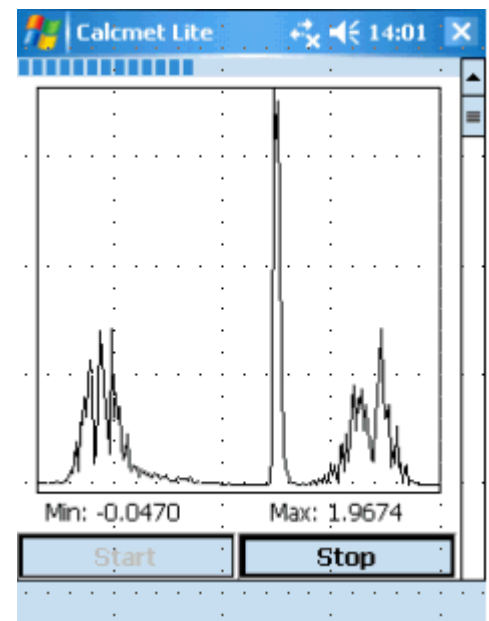


Fig.3. Sample IR Spectrum saved on DX-4030

Table 1. Typical measured gases with detection limits

Ready for use

The Gasmeter Dx-4030 FTIR Gas Analyzer is ideal for staff tasked with performing routine testing of WAG's in the Operating Rooms and Recovery rooms as it provides a simultaneous direct reading of all the Anesthetic agents. The user can immediately action any necessary maintenance when leaks are detected around the anesthetic machines, fittings or storage area and so saving valuable hospital resources and eliminating possible worker occupational health exposure issues.

Staff performing worker exposure monitoring may choose to setup the Dx-4030 in an optimal position either in the operating or recovery room(s) and monitor a worker's 8-hour TWA exposure to all the anesthetic gases used at that facility concurrently.

Powered either from AC power for long term (TWA) monitoring applications or running from battery power for performing leak detection or general room air quality surveys, the Dx-4030 provides the user an easy-to-use instrument without the fear of false alarm readings.

The instrument is fully ready to use after a three minute zeroing procedure usually performed daily. The zero gas is either an inert gas such as Nitrogen or air pumped through a zeroing filter assembly. Due to the inherent stability of an FTIR spectrometer, no other calibration procedures such as span gas calibrations are needed. After zeroing the Dx-4030 is ready to monitor, with gas readings displayed and stored for all 15 gases every 1,5, 20, 60 or 180 seconds (user changeable using Calcmet Lite.)

The communication between the Dx-4030 analyzer and the PDA uses Bluetooth wireless technology or an RS-232 cable link. The PDA interface runs Gasmeter Technologies' Calcmet Lite software on Windows® Mobile Intuitive Operating system. Calcmet Lite Software provides full instrument control including diagnostics, instrument settings, result display and saving data on a memory card. Validation occurs for each reading, warning the operator immediately of an unknown gas that has been detected. A quality assurance indicator labelled "residual" is tagged to each gas concentration collected.

When unknown gases are detected or if the user is responding to an indoor air quality issue, Calcmet Lite can store a sample spectrum as illustrated in figure 3. Using the optional Calcmet 4030 Pro Software and transferring this saved spectrum to a laptop or PC, the unknown gas as recorded by the Dx-4030 can be matched against a reference library containing 250 gases to quickly resolve this workplace complaint.

Maintenance

Providing all of the traditional benefits of infrared gas analyzers such as ease-of-use and low cost-of-ownership, the Dx-4030 gives a significant advantage for instrument calibration as it never has to be sent back to the factory for recalibration. System checks are recommended periodically where a known concentration of gas such as Nitrous Oxide is applied to the Dx-4030 to verify that there are no leaks or blockages throughout the gas analyzing system.

The next generation Gasmeter Dx-4030 FTIR Gas Analyzer offers the premium in cost effective monitoring solutions for to the healthcare industry, with complete protection against exposure to

any of the suite of waste anesthetic gases and significantly reducing time to perform routine surveys to monitor for anesthetic gas leaks.

