

Simultaneous measurement of Toxic Industrial Gases (TIC's):

Gasmeter Technologies New DX-4030 FTIR Gas Analyzer

As the pace of today's society continues to push deadlines harder and faster and the threat of breached security looms all around us, the need for vigilant monitoring programs as never been more important. Gasmeter Technologies "New Generation" Model DX-4030 Gas Analyzer provides a cost-effective solution to measure **25 TIC** gases simultaneously.

Traditionally, first responders, safety officers or industrial hygienist's have had to use monitoring tools that were a compromise of response time with either selectivity and/or sensitivity, now the new DX4030 provides both the analytical power (including selectivity and sensitivity) and speed in one small, portable and easy-to-use instrument.

Based on the same fundamental measurement principles of infrared spectrometers, a (Fourier Transform Infrared) FTIR utilizes the complete mid-infrared spectrum rather than individual wavelengths. Scanning at 10Hz (10 scans per second), the Dx4030 can provide accurate gas readings of 25 gases in just 5 seconds.

An internal sample pump actively samples the contaminated air with all 25 gas concentrations displayed and logged on a rugged and watertight PDA (Personal Digital Assistant) after just seconds from starting your gas monitoring.

The instrument is fully ready to use after zeroing (usually performed daily) with either non-contaminated ambient air or an inert gas such as Nitrogen.

The DX-4030 is then ready to monitor, with gas readings displayed and stored for all 25 gases each 5, 20, 60 or 180 seconds (programmable feature).

The communication between the DX-4030 analyzer and the PDA uses Bluetooth wireless technology. The PDA interface runs Gasmeter's "Calcmeter – Lite" software on Windows® CE Intuitive Operating system. Calcmeter – Lite Software provides full instrument control including diagnostics, instrument settings, results and saved data. 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.

Powered from a Li-ion rechargeable battery, the DX-4030 Gas Analyzer will provide up to 3 hours of continuous air quality readings. Hot-swapping batteries or using its AC power option allows the DX-4030 to be used in longer term air quality assessment applications.



Fig.1 – DX-4030 operating in the field

This new generation Model DX-4030 FTIR Multi-component Gas Analyzer delivers monitoring personnel a very easy-to-use instrument with the ability to rapidly monitor a suite of toxic gases thereby reducing response time which allows on-site hazardous conditions to be quickly assessed and vital decisions to be made and acted upon.

For Hazmat applications, the DX-4030 Gas Analyzer is supplied calibrated to measure the 25 gases listed in the table below (refer Table 1).

CAS No.	Gas Name	Chemical Formula	Range (ppm) ¹	Detection Limit ²	PEL's ³		
					TWA	STEL	Ceiling
107-02-8	Acrolein	C ₃ H ₄ O	0 - 5	0.25	0.1		
7664-41-7	Ammonia	NH ₃	0 - 100	0.13	25	35	
7784-42-1	Arsine	AsH ₃	0 - 50	0.02	0.05		
71-43-2	Benzene	C ₆ H ₆	0 - 20	0.13	1	5	25
10294-34-5	Boron Trichloride	BCl ₃	0 - 50	0.01			1
124-38-9	Carbon Dioxide	CO ₂	0 - 3 %	11	5000		
75-15-0	Carbon Disulphide	CS ₂	0 - 100	0.17	20	30	
630-08-0	Carbon Monoxide	CO ₂	0 - 500	0.25	50	200	
75-09-2	Dichloromethane	CH ₂ Cl ₂	0 - 200	0.1	100		
75-21-8	Ethylene Oxide	C ₂ H ₄ O	0 - 20	0.18	1	5	
50-00-0	Formaldehyde	CH ₂ O	0 - 50	0.09	0.75	2	
7647-01-0	Hydrogen Chloride	HCl	0 - 50	0.2			5
74-90-8	Hydrogen Cyanide	HCN	0 - 50	0.35			5
7664-39-3	Hydrogen Fluoride	HF	0 - 50	0.3	3		
74-82-8	Methane	CH ₄	0 - 100	0.06			
74-93-1	Methylmercaptan	CH ₄ S	0 - 100	0.41			10
10102-44-0	Nitrogen Dioxide	NO ₂	0 - 50	0.37			5
10024-97-2	Nitrous Oxide	N ₂ O	0 - 100	0.02	25		
75-44-5	Phosgene	CCl ₂ O	0 - 10	0.018	0.1		
7803-51-2	Phosphine	PH ₃	0 - 20	0.200	0.3	1	
2699-79-8	Sulfuryl Fluoride	SO ₂ F ₂	0 - 20	0.03	5		
7446.09.5	Sulphur Dioxide	SO ₂	0 - 20	0.03	2	5	
108-88-3	Toluene	c ₆ H ₅ CH ₃	0 - 500	0.13	200		
7732-18-5	Water Vapour	H ₂ O	0 - 3 %	n/a			

Table 1 – Standard gases calibrated in DX-4030 for Hazmat Application

1. Range - Typical recommended range however can be changed if application requires alternate gas measurement ranges. Consult Gasmeter for maximum & minimum range for a specific gas calibration.
2. Lower Limit Detection based on 60 sec. measurement time.
3. PEL's : Occupational Exposure Limits - Data per OSHA or NIOSH or ACGIH

Maintenance: Providing all of the traditional benefits of infrared gas analyzers such as ease-of-use and low cost-of-ownership, the DX-4030 provides the user a significant advantage for instrument calibration as – it never has to be sent back to the factory for recalibration. The DX-4030 performs a wavelength validation with every measurement using an internal high precision HeNe (Helium Neon) laser. System checks are recommended periodically where a known concentration of gas is applied to the DX-4030 to verify there are no leaks or blockages throughout the gas analyzing system.



Fig.2 – PDA displaying results from Calcmeter Lite Software

Periodic inspection and change of the particle filter should be performed each 3 – 6 months dependent upon frequency and conditions where instrument is being used.

When unknown gases are detected* or if the user is responding to a situation where the source of the air contaminant is not known, Calcmeter-Lite can store a sample spectrum as illustrated in figure 3.. Using the optional Calcmeter Standard or 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 over 250 gases to quickly identify the unknown gas.

Once identified, the Calcmeter software can be used to download the calibration to the DX-4030 so the gas concentration of this new gas can be continuously monitored at site.

* : An unknown gas will be detected by the DX-4030 and reported to the operator by a high residual alarm

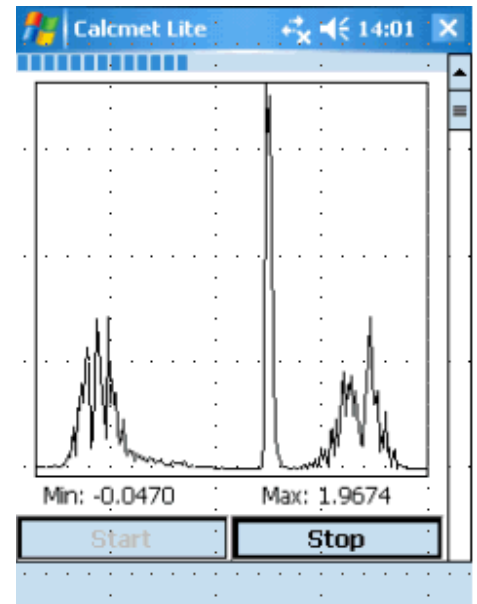


Fig.3 – Sample IR Spectrum saved on DX-4030

Gaset Technologies is a world-leading high technology company that focuses on the design and manufacture of FTIR Gas Analyzers and is headquartered in Helsinki, Finland. It released its first-generation of FTIR Gas Analyzers in 1993 and their rugged design and quality of manufacture found them being routinely used in Continuous Emissions Monitoring (CEMS) for incinerators and stacks worldwide. In 2005, Gaset released an In-situ FTIR Gas Analyzer, a world-first. The combination of ruggedness, reliability and analytical power made the Gaset Analyzers a natural choice for Military Departments worldwide for protecting their soldiers against exposure to chemical warfare gases.

Industrial facilities have come to rely on Gaset for providing analytical solutions to their tough monitoring applications. Universities are using the Gaset to research the effects increasing concentrations of Greenhouse Gases are having on plant physiology. Now Gaset is pleased to provide Emergency Responders, Safety Personnel and Industrial Hygienists' a new generation solution to their gas testing requirements with the release of the world's first truly portable FTIR Gas Analyzer, the Model DX-4030.

Explaining FTIR measurement technology –

Infrared radiation interacts with all molecules [except the homonuclear diatomics oxygen (O₂), nitrogen (N₂), hydrogen (H₂), chlorine (Cl₂), etc.] by exciting molecular vibrations and rotations. The oscillating electric field of the IR wave interacts with the electric dipole of the molecule, and when the IR frequency matches the natural frequency of the molecule, some of the IR power is absorbed. The pattern of wavelengths, or frequencies, absorbed identifies the molecules in the sample. The strength of absorption at particular frequencies is a measure of their concentration. (Beer's Law)

As illustrated in Figure 4, traditional infrared analyzers also called non-dispersive infrared (NDIR) use optical filters to allow only specific narrow wavelengths of light to pass through the measurement gas cell and reach the detector. This simple optical arrangements leads itself quite well to single gas measurement.

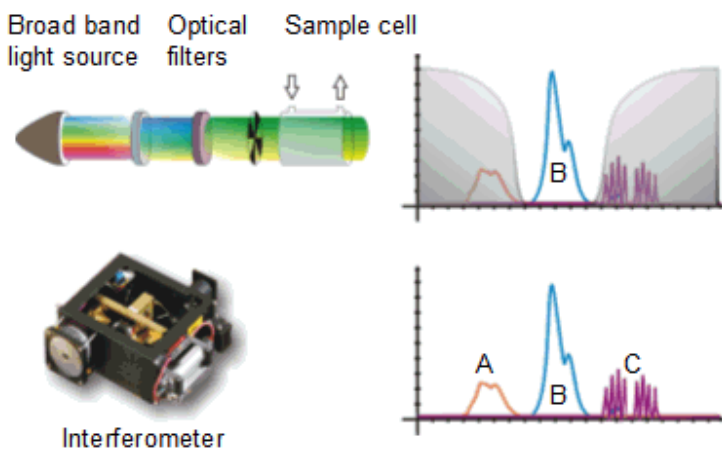


Fig 4. Traditional NDIR (top) FTIR Gas Analyzer (bottom)

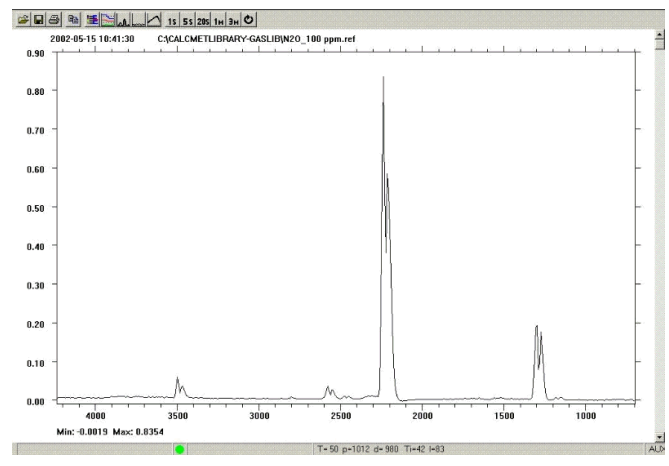


Fig 5. Infrared Spectrum for Nitrous Oxide (N₂O)

In an FTIR Gas Analyzer, the complete IR spectrum typically $900 - 4,200 \text{ cm}^{-1}$ is scanned at 10Hz. An FTIR Analyzer, initially creates an interferogram by first splitting the infrared light beam in two beams of nearly equal power and then recombining them in such a way that intensity variations of the combined beam can be measured as a function of differences in the length of the path of the two beams. A device called the Interferometer for modulating optical radiation was first designed by Albert Michelson, an American optical physicist, late in the nineteenth century.

This beam splitting is achieved by using one fixed and one moving mirror. Through this process the complete infrared spectrum is encoded in the signal. This resultant signal is then processed using a Fast Fourier Transformation (FFT) to produce an intensity (absorbance) versus frequency spectrum. So that the exact position of the moving mirror is known at all times, a NeHe laser with a frequency of 632.8 nm follows the exact path as the IR beam which provides an optical calibration with each gas measurement. Illustrated in figure 5. is the complete IR spectrum for the gas, Nitrous Oxide produced by the Gasmeter FTIR Gas Analyzer.

Using a patented modified Classical Least Squared (CLS) algorithm, the Gasmeter Calcmet-Lite Software matches the calibration spectra of stored gases (25 gases in the DX-4030 and up to 50 gases in the DX-4015) against the sample spectrum. The Calcmet-Lite Software then displays the gas concentration measured for each of the 25 gases and it reports a "residual" associated with each gas which tells the user if another gas is present in the sample. If the residual is low (ie <0.01) a green status is displayed for the measured gas providing the user with assurance that no false identification of the measured gas has occurred. Warnings are given when Calcmet-Lite detects high residual values which alerts the user that a gas not being measured is present in the sampled air. 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 over 250 common ambient air gases.

As the infrared spectrum of a gas is a constant at a given pressure (P) & temperature (T), it means an accurately prepared gas calibration spectrum can be stored in the DX-4030 for each gas and it will not change with time. (P & T compensation applied). Optical alignment is verified with each reading by the NeHe laser. For FTIR Gas Analyzers like the DX-4030 no routine gas calibration is required. Simply recording a daily background or zero spectrum prior to taking sample measurements is all that is needed.