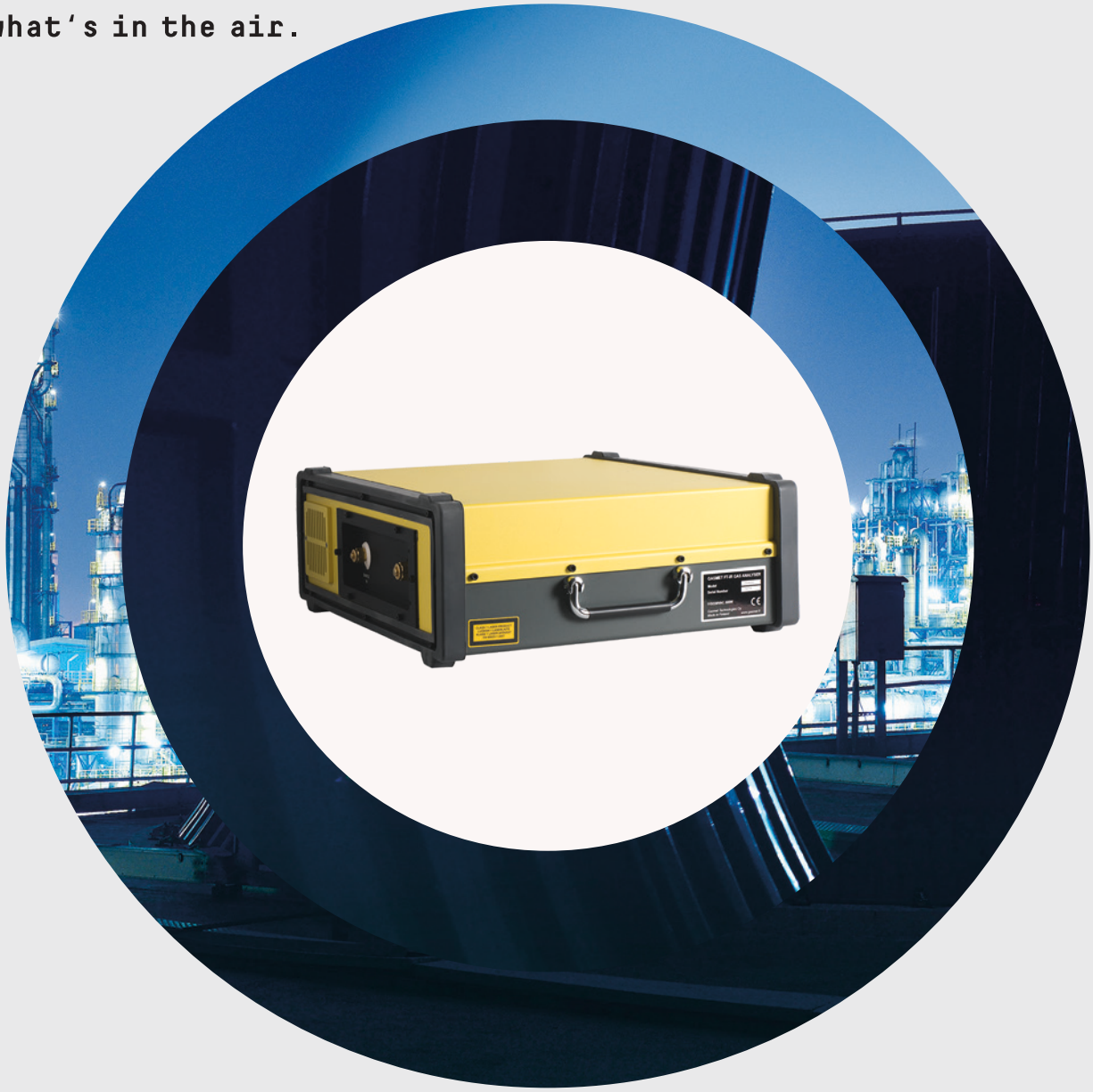
gasmet

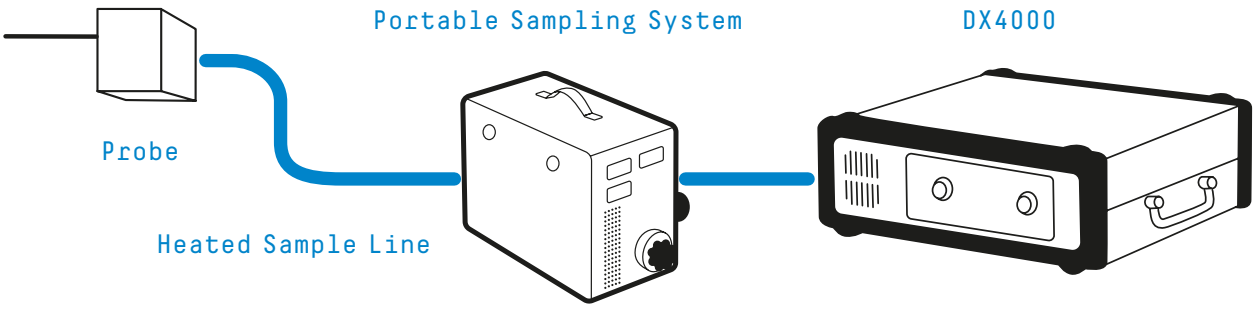
> Know what's in the air.



DX4000

Gasmet Portable FTIR Gas Analyzer DX4000

The Gasmet DX4000 FTIR Gas Analyzer is the most powerful tool available for emissions monitoring, process gas analysis and compliance testing.



What is the DX4000?

The Gasmet DX4000 is a portable multicomponent FTIR analyzer that is designed for monitoring gas concentrations in hot, wet and corrosive gas streams. Together with Gasmet's Portable Sampling System (PSS), it forms a complete portable FTIR emissions monitoring system offering the same high quality performance as Gasmet's fixed systems in an easy-to-transport package. The Gasmet DX4000 has received the MCERTS 15267-3 certification for stack emissions monitoring.

The entire sampling train of the DX4000 and PSS is heated to 180 °C, allowing for a direct sampling of hot and wet sample gas without the need for pre-conditioning the sample. The system is easy to operate and gives accurate results, as no analyte (sample) gases will be lost in the conditioning of the sample. The Gasmet DX4000 FTIR Gas Analyzer is the most powerful tool available for emissions monitoring, process gas analysis and compliance testing.

The compact and modular design of the system allows the analyzer to be easily transported and quickly assembled, allowing for fast mobilization and less time wasted in waiting to conduct the analysis. The system is operated by the powerful, yet easy to use, Calcmet software on a PC computer. The Calcmet software offers all the tools needed for challenging measurement campaigns.

The Gasmet DX4000 utilizes Fourier Transform Infrared (FTIR) spectroscopy, which is a powerful gas measurement technology. FTIR spectroscopy works by scanning and analyzing the entire infrared spectrum in order to measure all infrared-absorbing gases in the sample simultaneously. Most molecules have a characteristic absorption spectrum that can be used to identify gases and accurately measure their concentration.

DX4000 is the world's smallest FTIR emissions monitoring system.

What is it used for?

Due to the flexibility of the FTIR technology, the DX4000 can be used in a wide variety of applications, ranging from research applications to process measurements and emissions monitoring. Typical uses include:

> Stack testing: QAL2 tests for HCl, NH_3, SO_2, NOx and other gases
> Scrubber and catalyst efficiency tests
> Combustion and engine R&D
> PFC emissions at Aluminum and Semiconductor plants
> Carbon capture and sequestration
> Formaldehyde emissions from biogas
> Formaldehyde emissions from biogas

Why should I buy the Gasmet DX4000?

> Portable
> Easy assembly on-site
> Addition of new gases & ranges without hardware changes
> No pre-conditioning of samples
> Online results
> MCERTS-certified
> Simultaneous measurement of all gases

Which gases can be measured?

The DX4000 can be used to measure up to 50 different gases. In combustion processes, the DX4000 is typically used to measure the following gases simultaneously:

Typically measured gases	
Water, H_2O	Hydrogen Fluoride, HF
Carbon Dioxide, CO_2	Ammonia, NH_3
Carbon Monoxide, CO	Methane, CH_4
Nitrous Oxide, N_2O	Ethane, C_2H_6
Nitric Oxide, NO	Propane, C_3H_8
Nitrogen Dioxide, NO_2	Ethylene, C_2H_4
Sulfur Dioxide, SO_2	Formaldehyde, CH_2O
Hydrogen Chloride, HCl	Oxygen, O_2

The DX4000 is one of the most powerful tools available for challenging gas measurements. The amount of measurable gases is unparalleled, and the system is easy to configure to measure new compounds without the need for hardware changes. Please contact your local Gasmet representative for more available compounds, ranges and to ask for additional information.

GAS-APP-003 ⁝ Extended CEM application

24.1.2022

#	Compound name	Formula	CAS number	Minimum range	Typical range	Maximum range	Unit
1	Water	H_2O	7732-18-5	25	30	40	vol-%
2	Carbon dioxide	CO_2	124-38-9	10	20	30	vol-%
3	Carbon monoxide	CO	630-08-0	60	500	10000	ppm
4	Nitrous oxide	N_2O	10024-97-2	50	100	500	ppm
5	Nitrogen monoxide (Nitric oxide)	NO	10102-43-9	100	200	2000	ppm
6	Nitrogen dioxide	NO_2	10102-44-0	100	200	500	ppm
7	Sulfur dioxide	SO_2	7446-09-5	30	100	2000	ppm
8	Ammonia	NH_3	7664-41-7	20	50	500	ppm
9	Hydrogen chloride	HCl	7647-01-0	10	50	500	ppm
10	Hydrogen fluoride	HF	7664-39-3	3	10	100	ppm
11	Methane	CH_4	74-82-8	20	100	1000	ppm
12	Ethane	C_2H_6	74-84-0	*		200	ppm
13	Ethylene (Ethene)	C_2H_4	74-85-1	*		200	ppm
14	Propane	C_3H_8	74-98-6	*		200	ppm
15	Hexane	C_6H_{14}	110-54-3	*		100	ppm
16	Formaldehyde	HCOH	50-00-0	15		70	ppm

* The CEM hydrocarbon ranges depend on the application.
Higher ranges and additional compounds are available upon request from Gasmet Technologies Oy.
Note: Standard GAS-APP-003 application package includes one range per compound.

gasmet

DX4000

Portable FTIR emissions monitoring system

The worlds smallest FTIR emissions monitoring system

A COMPLETE MEASUREMENT SYSTEM

- The DX4000 coupled with Gasmet Portable Sampling System (PSS) offers a complete measurement system with everything you need to make quality measurements
- MCERTS certified

MODULAR DESIGN

- The system is comprised of compact modules that are easy to carry to site for assembly

System parts

DX4000 ANALYZER

- Robust & portable FTIR analyzer
  Designed for measurements in demanding industrial conditions
- 13.9 kg

PSS – PORTABLE SAMPLING SYSTEM

- Specifically designed for use with the DX4000 analyzer
- Hot extractive sampling in a portable package
  - All system parts exposed to sample are heated to 180 C
- 12.3 kg
- Internal pump with ~4 l / min flow

CALCMET

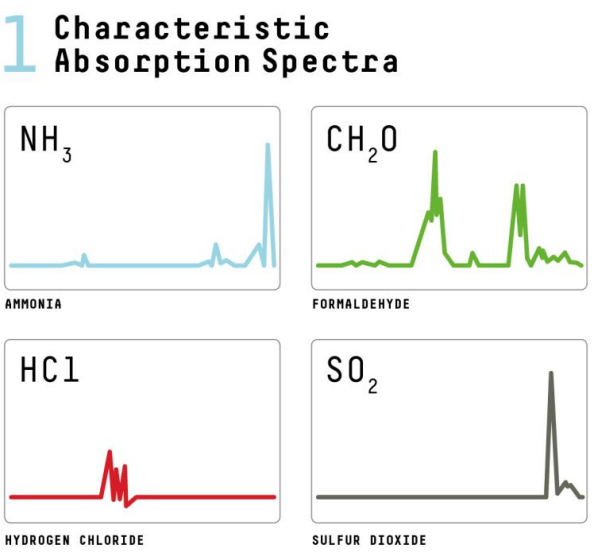
gasmet > Know what's in the air.

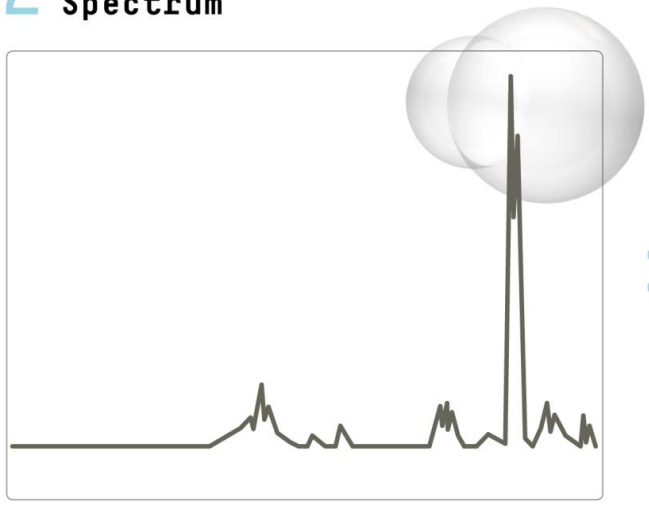
Power of FTIR

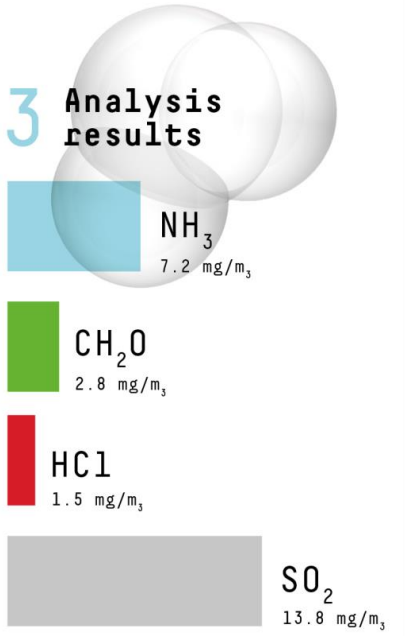
ADVANTAGES OF FTIR

- **True multicomponent measurements**
- **On-line results**
- **Adding new components is easy and affordable**

FTIR

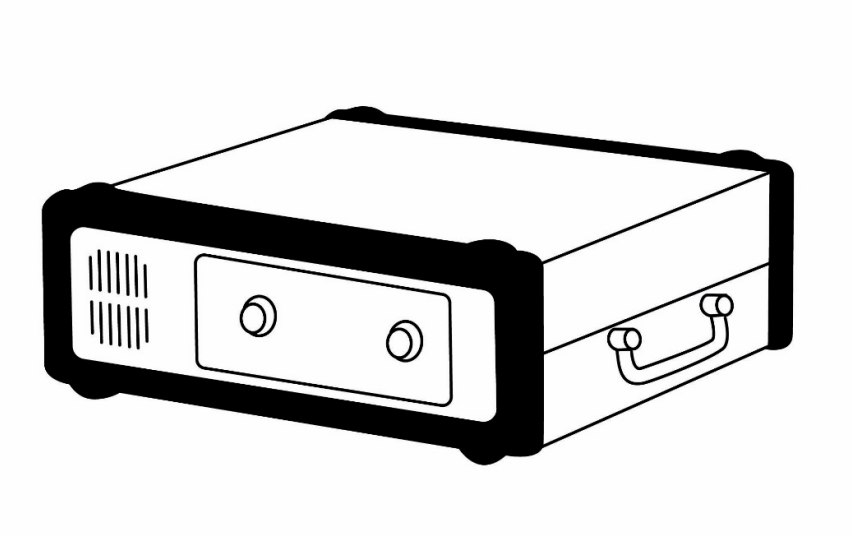

1 Characteristic Absorption Spectra
NH3
AMMONIA
CH2O
FORMALDEHYDE
HCl
HYDROGEN CHLORIDE
SO2
SULFUR DIOXIDE


2 Measurement Spectrum


3 Analysis results
NH3
7.2 mg/m3
CH2O
2.8 mg/m3
HCl
1.5 mg/m3
SO2
13.8 mg/m3

v1.12

DX4000 FTIR gas analyzer



Multicomponent FTIR Gas Analyzer

Gasmet On-site Series includes portable multicomponent gas analyzers for demanding applications. The Gasmet DX4000 incorporates a Fourier transform infrared, FTIR spectrometer, a temperature-controlled sample cell, and signal processing electronics. The analyzer offers versatility and high performance for all users.

The Gasmet DX4000 is designed for short term on site measurements with wide dynamic ranges. It is an ideal tool to measure trace concentrations of pollutants in wet, corrosive gas streams. The sample cell can be heated up to 180 °C. Sample cell absorption path length is selected according to the application.

The Gasmet DX4000 allows simple calibration using only single component calibration gases. The user can easily configure the analyzer for a new set of compounds.

General parameters

Measuring principle:	Fourier transform infrared, FTIR
Performance:	Simultaneous analysis of up to 50 gas compounds
Response time, T_{90}:	Typically < 120 s, depending on the gas flow and measurement time
Operating temperature:	Short term 0 - 40 °C long term 5 - 30 °C non-condensing
Storage temperature:	-20 - 60 °C, non-condensing
Power supply:	100-115 or 230 V / 50 -60 Hz
Power consumption:	Average 150 W, maximum 300 W

Spectrometer

Resolution:	8 cm^{-1} or 4 cm^{-1}
Scan frequency:	10 scans / s
Detector:	Peltier cooled MCT
Source:	SiC, 1550 K
Beamsplitter:	ZnSe
Wave number range:	900 - 4 200 cm^{-1}

Sample cell

Structure:	Multi-pass, fixed path length 5.0 m
Material:	100 % rhodium coated aluminum
Mirrors:	Fixed, protected gold coating
Volume:	0.4 liters
Connectors:	Inlet Swagelok 6 mm Outlet Swagelok 8 mm
Gaskets:	Viton® O-rings
Temperature:	180 °C, maximum
Window material:	BaF_2

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v1.12

Measuring parameters

Zero-point calibration:	24 hours, calibration with nitrogen (5.0 or higher N_2 recommended)
Zero-point drift:	< 2 % of measuring range per zero-point calibration interval
Sensitivity drift:	None
Linearity deviation:	< 2 % of measuring range
Temperature drifts:	< 2 % of measuring range per 10 K temperature change
Pressure influence:	1 % change of measuring value for 1 % sample pressure change. Ambient pressure changes measured and compensated

Electrical connectors:

Digital interface:	9-pole D-connector for RS-232
	Analyzer is connected to an external computer via RS-232C cable. The external computer controls Gasmet.
	Remote control connection for Portable sampling unit
Power connection:	Standard plug CEE-22
PSS connection:	Remote connection of PSS (Portable Sampling System)

Gas inlet and outlet conditions

Gas temperature:	Non-condensing, the sample gas temperature should be the same as the sample cell temperature
Flow rate:	120 - 600 liters per hour[M1][JE2]
Gas filtration:	Filtration of particulates (2 µm) required
Sample gas pressure:	Ambient
Sample pump:	External, not included

Electronics

A/D converter:	Dynamic range 95 dB
Signal processor:	32-bit floating point DSP 120 MFLOPS speed
Computer:	External, not included

Analysis software (for external PC)

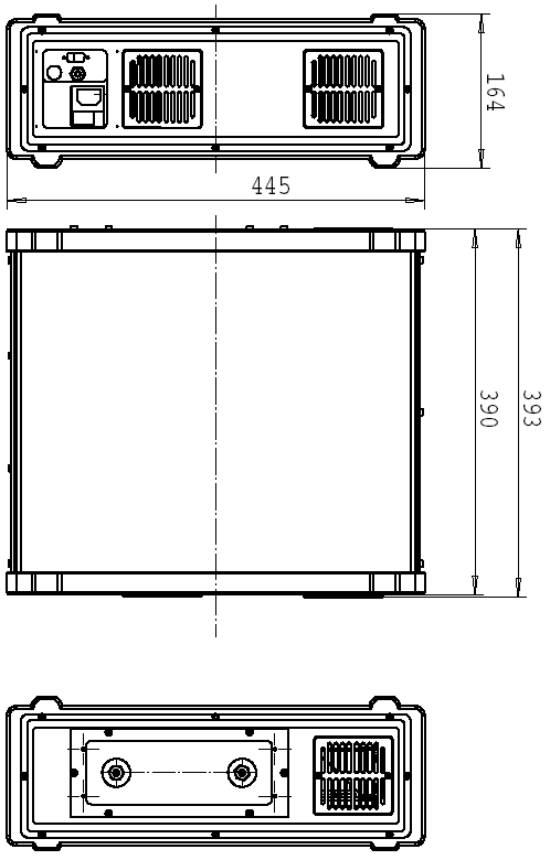
Operating system:	Windows 7 or Windows 10
Analysis software:	Calcmet for Windows

Options

Sample cell:	Multi-pass, fixed path length 2.5 m or 9.8 m
Pressure measurement:	Inside sample cell
Analog signals (ext. PC):	TCP module (for analog inputs, outputs, relays)
Sample cell gaskets:	Kalrez®
Trolley:	Wheeled cart for the analyzer and laptop computer

Enclosure

Material:	Aluminum
Dimensions (mm):	390 * 445 * 164
Weight:	13.9 kg
CE label:	According to EMI guideline 89/336/EC



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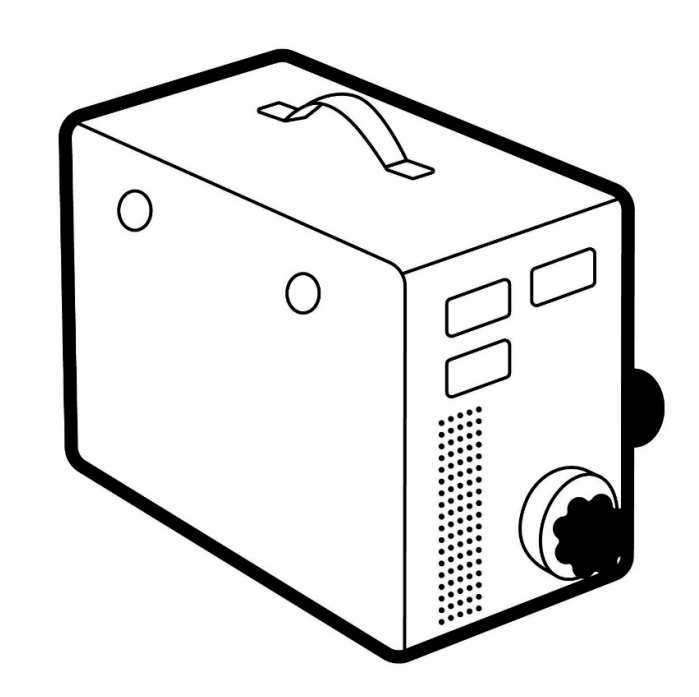
Portable Sampling System



Gasmet Portable Sampling System

The Gasmet portable sampling system has been designed for portable emission monitoring measurements.

The Gasmet portable sampling system is used for on-site measurements. It can be used for measuring trace concentrations of pollutants in wet, corrosive gas streams. The sample gas can be measured undiluted and without drying since the sample pump, heated filter and valve are located in a module that is heated to 180 °C. From the sampling system the gases can be directed into Gasmet FTIR gas analyzer.

The Gasmet portable sampling system includes power connections and temperature controllers for heated lines and heated module. The Gasmet portable sampling system is connected to an external PC through Gasmet FTIR gas analyzer and can be controlled by Calcmet software.

The function of the portable sampling system is automatic, but sample pump and valve can be controlled also manually.

In the case of a power failure or if the temperature (pump, lines, sample cell) is below setting, the automatic 3-way valve switches sample gas to zero gas to prevent condensation. Sample pump cannot be switched on before all temperatures have reached the setting. In addition, the zero calibration of the Gasmet FTIR gas analyser can be done automatically with the portable sampling system.

As an option, the sampling system can be equipped with a sample probe and/or heated lines. The maximum length for the heated line is 19 m + 1 m with 230 VAC and 9 m + 1 m with 115 VAC power supply. There is also an optional integrated O_2 sensor that supplements the capabilities of the Gasmet FTIR gas analyzers.

General parameters

Operating temperature:	20 ± 20 °C, non-condensing
Storage temperature:	-20 – 60 °C, non-condensing
Power supply:	Separate models for 100-115 and 230 V / 50 -60 Hz
Power consumption:	400 - 3600 W, depending of the sample lines (without sample probe)

Heated sample pump

Material:	316 SS
Diaphragms:	Teflon
Maximum flow:	~4 l/min, constant
Temperature:	180 °C, maximum

Heated filter

Material:	Bonded microfiber (sintered steel 0.1µ as an option)
Gas filtration:	Filtration of particulates (2 µm)
Temperature:	180 °C

Temperature controllers

Material temperature range:	0 – 180 °C
Display:	Digital, 3 digits

Valves

Pressure:	0 - 2 bars
Temperature:	60 °C maximum
Valves:	Sample gas/zero gas

Gas connectors

Sample gas inlet:	One piece, 6 mm Swagelok
Sample gas outlet:	One piece, 6 mm Swagelok
Zero gas inlet:	One piece, 6 mm Swagelok

Electrical connectors

Power connection:	CEE7 standard European Schuko plug or fixed cable

Enclosure

Material:	SS 316
Dimensions (mm):	400 × 300 × 210 mm
Weight:	12.3 kg
CE label:	EMI guideline 89/336/EC

Optional oxygen sensor

The O_2 concentration reading can be displayed on the Calcmet software

Principle:	ZrO_2 cell
Measuring range:	0.1 – 25 %
Accuracy:	< 2% from FS
Calibration:	Single point calibration with air

Optional heated line

Tube size:	4 mm, inner diameter
Core material:	Teflon core
Operating pressure:	Maximum 400 kPa
Temperature:	Maximum 200 °C
Fittings:	6 mm Swagelok
Power supply:	230 VAC or 115 VAC
Power density:	120 watts/meter

The maximum length of the heated line is 19 m + 1 m (230 VAC) and 9 m + 1 m (115 VAC).

Optional sample probe

Sample probe: PSP4000H

- **Power density:** 320 watts
- **Operating temperature:** 0 – 180 °C
- **Filter element:** Ceramic (2 µm)
- **Dust loadings:** < 2 g/m^3

Probe tube material: SS 316 Viton

- **Probe length:** One (1) meter
- **Sample temperature:** 600 °C maximum
- **Sample pressure:** 1 bar maximum

Other probes for high temperatures and for high dust loadings.

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Gasmet

WHITE PAPER

FTIR GAS ANALYSIS

INTRODUCTION

FTIR (Fourier Transform InfraRed) spectroscopy is the most popular analytical technology for industrial applications requiring the continuous measurement of multiple parameters simultaneously, Typically, FTIR analyzers are employed for process control and emissions monitoring, however, due to the robustness and flexibility of this technique, it can also be applied in a wide variety of different applications, which will be discussed in greater detail below.

FTIR gas analyzers identify and measure gaseous compounds by their absorbance of infrared radiation. This is possible because every molecular structure has a unique combination of atoms, and therefore produces a unique spectrum when exposed to infrared light. Instrumental analysis of the spectrum (2 to 12 micrometer wavelength) enables the qualitative identification and quantitative analysis of the gaseous compounds in the sample gas. Importantly, FTIR analyzers are able to simultaneously measure multiple analytes in complex gas matrices, detecting virtually all gas-phase species (both organic and inorganic, except diatomic elements N_2, O_2 etc. and noble gases He, Ne, etc.). For example, the Gasmet™ FTIR gas analyzer collects a complete infrared spectrum (a measurement of the infrared light absorbed by molecules inside the sample gas cell) 10 times per second. Multiple spectra are co-added together according to a selected measurement time (improving accuracy by raising the signal-to-noise ratio). The actual concentrations of gases are calculated from the resulting sample spectrum using a patented modified Classical Least Squares analysis algorithm.

TYPICAL APPLICATIONS

The ability of FTIR to monitor multiple gases simultaneously, even in hot, wet aggressive gas streams means that it is ideal for emissions monitoring in the power sector, energy from waste, incineration plants and in industries such as cement and aluminium. These processes have to demonstrate compliance with emissions limit values specified in regulatory permits using instrumentation with appropriate certification (a list of Gasmet's comprehensive certification is given below).

A number of typical configurations exist for monitoring emissions including parameters such as CO, NO, H_2O, SO_2, HCl, NH_3, NO_2, N_2O, CO_2, HF, CH_4 and CHOH. However, with the ability to monitor thousands of compounds, the opportunities for industrial process monitoring with FTIR are endless.

The emissions from all types of engines are monitored for compliance purposes and also to improve engine efficiency. Again multigas capability is required and FTIR is therefore commonly applied. With increasing concern over the impact of vehicle emissions on ambient air quality, FTIR is a popular monitoring technique with engine developers; providing an opportunity to refine engine performance whilst measuring the effects on the individual components of emitted gases.

In addition to emissions monitoring, Gasmet FTIR analyzers are also employed in other environmental applications, particularly where multigas monitoring is required or where it is necessary to be able to identify unknown gases. Portable and ambient versions of the same FTIR technology are therefore available and are employed in applications such as greenhouse gas monitoring in soils, contaminated land, chemical leak/spill, fire investigation etc.

Gasmet FTIR analyzers are also used in occupational safety applications such as anaesthetic gases, shipping container investigation, fumigation and testing of compressed breathing air for impurities.

FTIR GAS ANALYZER VERSIONS

Gasmet FTIR analyzers are available in a variety of different formats to meet the requirements of different applications. The core FTIR technology is exactly the same in every model, so all users, working in any application, can rely on the same high levels of accuracy and reliability. The main models are as follows:

1. Fixed Continuous Emissions Monitoring System - the CEMS II *e* has enhanced certification for the monitoring of multiple gases. The FTIR analyzer, a heated sampling unit, an industrial PC and a Zirconia oxygen analyzer are installed in an air-conditioned cabinet for the analysis of up to 50 compounds simultaneously in extracted gases.

2. Portable heated FTIR - the DX4000 analyzer employs the same technology as the CEMS II *e* for the analysis of extracted gases in a portable housing weighting less than 20 kg (40 lbs).

3. Portable ambient gas FTIR analyzer – the DX4040 is a battery powered analyzer capable of measuring up to 25 parameters simultaneously, with remote PDA control via Bluetooth.

4. Fixed multipoint ambient FTIR gas analyzer – the Gasmet FCX incorporates an FTIR analyzer with a built-in industrial computer and a TFT display in a compact IP65 rated stainless steel wall mounted enclosure.

5. Stack/duct mounted FTIR gas analyzer – the Gasmet In-Situ analyzer consists of a sample cell inserted into the stack or duct, a heated steel mounting flange and the rugged GICCOR™ interferometer unit in an IP65 enclosure that is directly attached to the flange. With no sample extraction, response time is faster. However, extractive FTIR should be employed: with wet stacks where the gas temperature is down to the dew point; in very hot stacks with gas temperature above 250°C, and in ducts with diameter less than probe length (c.700 mm).

FTIR – COMMON QUESTIONS

1. WHAT IS AN FTIR SPECTROMETER? AND HOW DOES IT WORK?

A FTIR spectrometer consists of the following key components:

- A broadband IR source emitting all recorded wavelengths simultaneously
- Beamsplitter which separates the IR beam into two equal parts
- A moving/stationary mirror assembly where the two beams travel a distance which can be varied by moving one or more mirrors continuously back and forth
- A reference laser source, which is used to track the position of the moving mirror
- Focusing optics used to transfer the beam into the sample cell and from the sample cell into the detector
- Sample cell filled with sample gas or test gas
- IR detector which responds to the entire wavelength range of the spectrometer
- Laser detector which responds to the wavelength of reference laser used

The beamsplitter and moving/stationary mirror assembly are collectively known as the **interferometer** and this is the heart of a FTIR spectrometer. Due to the motion of mirrors, the two beams produced by beamsplitter have a phase difference and when they recombine at the beamsplitter the produced IR intensity varies with mirror position. The interferometer can be considered an optical modulator and the modulation of the beam is the key to calculating intensity at each frequency from the signal recorded by IR detector.

The IR detector records a signal as a function of time (or mirror position, as the moving mirror has a constant speed) known as the interferogram. This signal is linked with the IR spectrum by a Fourier transformation, a mathematical tool for converting time domain signal I(t) to a frequency domain signal I(f). By placing a sample cell between the interferometer and the detector, the spectrometer can be used to measure an absorption spectrum of the sample gas, and the identity and concentration of gases in the sample can be calculated from the absorption spectrum.

2. What is an Infrared Spectrum?

The infrared spectrum is a plot of infrared radiation related quantities as a function of wavelength or wavenumber. There are three commonly used quantities for an infrared spectrum:

Intensity (I), is a measure of IR light falling on the detector, and this can have a unit of power per surface area but more commonly this is represented on a unitless scale of detector counts.

Transmittance (T), is the ratio of Intensity measured with sample gas in the sample cell (sample spectrum) and Intensity measured with zero gas in the sample cell (background spectrum). Transmittance is a unitless number and is typically expressed as percentage (0 - 100%). The reason why Intensity is commonly represented by detector counts instead of SI units of power/area is that the same units are used for both I and I_0 when calculating transmittance and they cancel each other.

Absorbance (A), is a logarithm of Transmittance with reversed sign. Absorbance is particularly useful for gas analysis because it is directly proportional to gas concentration unlike Transmittance or Intensity. The x-axis of an IR spectrum can be either wavelength in micrometers (microns) or more commonly wavenumber in reciprocal centimeter units. Wavenumbers are in common use as the spacing of spectral lines in IR spectrum is more constant in wavenumber than wavelength scale. The table below shows some common wavelengths and wavenumbers.

Table 1 Common wavelengths and wavenumbers

	Wavelength	Wavenumber
Boundary of IR and Microwave scale	500 µm	20 cm^1
Low end of Mid-IR scale	20 µm	500 cm^{-1}
High end of Mid-IR scale	2.5 µm	4000 cm^{-1}
Visible red	0.77 µm (770 nm)	13000 cm^{-1}
Typical Gasmet spectral range	12 µm to 2.5 µm	900 cm^{-1} to 4200 cm^{-1}

A typical infrared spectrum of HCl gas is shown below. The HCl molecules vibrate with a frequency that corresponds to the gap in the middle of the spectrum, and the individual lines are due to combinations of vibration and rotation of the molecules. This pattern is unique to HCl and each gas has a corresponding 'fingerprint' which is different to the spectra of other gases, forming the basis of identification. The peak heights in absorbance scale are also proportional to gas concentration, which is the basis of quantification of gases from the spectrum.

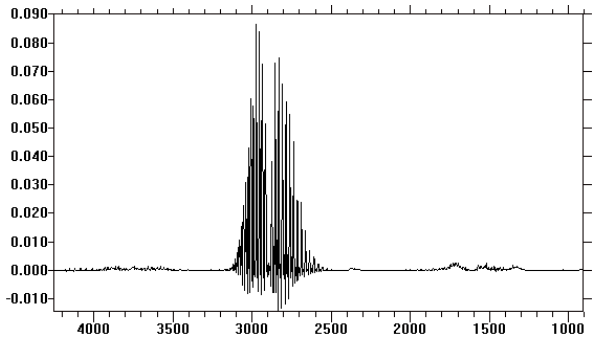

Figure 2 Infrared spectrum for HCl

3. How is the IR spectrum used for the quantification of gases?

The amount of light passing through an absorbing medium decreases exponentially as the thickness of the absorber is increased (Figure 2). In the case of gas analysis the absorber is the sample cell filled with IR absorbing gas. Absorbance at a given wavelength (λ) is a logarithm of transmittance, $A = \log_{10}(I/I_0)$, and is directly proportional to gas concentration (c), the distance travelled by the IR beam in the sample gas (b), and a gas specific constant (ε) known as molar absorptivity. The relation can be expressed as the Lambert-Beer law: $\mathbf{A(\lambda) = \varepsilon(\lambda) \times b \times c}$

In this equation, the concentration c is the quantity to be determined, A is taken from the measured spectrum, ε from the reference spectrum (see below) and pathlength b is a known quantity of the FTIR gas analyzer. The actual quantification is achieved by building a model spectrum from the reference spectra and matching them against the sample spectrum over a wide range of wavelengths to determine concentrations of multiple gases simultaneously. The illustration below shows how light intensity drops when the beam passes through a thickness of IR absorbing sample gas.

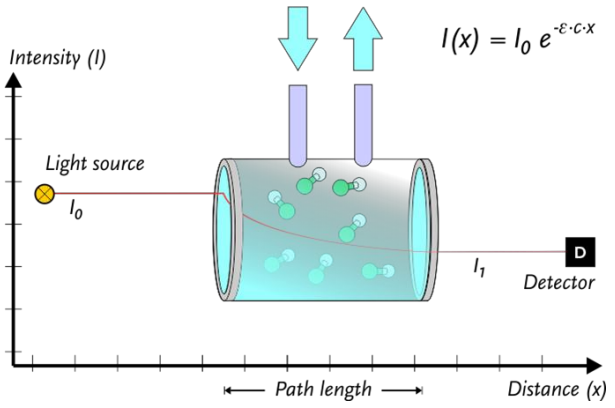

FIGURE 3: LAMBERT-BEER LAW AND ABSORBANCE

4. WHAT IS A REFERENCE SPECTRUM?

A reference spectrum is a spectrum of known concentration of one IR absorbing gas diluted in nitrogen. Reference spectra are used to analyze measured sample spectra. The absorption peaks in a sample gas are compared with those of reference spectra to determine simultaneously the concentrations of multiple gas components of the sample. For instance, if the absorption due to Methane in the sample is 1.2 times that of a 10 ppm Methane reference spectrum, the concentration of Methane is 12 ppm.

The reference spectrum is recorded using a long measurement time to eliminate noise from the spectrum and the instrument is carefully purged to eliminate traces of moisture and carbon dioxide (the two main atmospheric IR absorbing gases) from the spectrum. In order to model moisture and carbon dioxide in the sample, reference spectra of these gases are used.

5. WHICH GASES CAN BE MEASURED BY THE GASMET™ FTIR GAS ANALYZERS?

IR absorption spectroscopy such as FTIR detects those gases that absorb infrared radiation in internal motion (vibration) of the molecule. The absorption strength of a gas depends on the change of dipole moment (separation of electric charge) caused by the vibration. A molecule with strongly varying dipole moment absorbs radiation strongly whereas a molecule with no net change of dipole moment is transparent to IR radiation. Most molecules absorb IR light and are therefore measurable. However some molecules (N_2, O_2, H_2, Cl_2, …) and all single-atom gases (He, Ne, Ar, Hg, …) do not change dipole moment and therefore they do not have an IR absorption spectrum. These gases, especially Nitrogen, can be used as a zero gas for recording a background spectrum (I_0). The gases measured by FTIR include:

- Inorganic gases: Water, CO2, CO, NO, NO2, N2O, NH3, SO2, HCl, HF, …
- Volatile organic compounds: hydrocarbons, alcohols, aldehydes, ketones, freons, …
- The main exceptions are:
- noble gases (He, Ar, …)
- metals (Hg)
- molecules with just two atoms of the same element (N2, O2, H2, Cl2)
- molecules with very small dipole moment change (H2S)
- low volatility organics (high boiling point or room temperature solid)
- particulate matter or aerosols (not a gas)

6. WHAT IS THE TYPICAL PERFORMANCE OF GASMET™ FTIR GAS ANALYZERS IN EMISSIONS MONITORING APPLICATIONS?

Gasmet FTIR analyzers meet the performance requirements laid down in EN 15267-3 (Europe) and PS 15 (U.S). Linearity deviations are less than 2% of full scale and cross-interference effects due to stack emissions gas (H_2O up to 40 vol-%) are less than 4% of full scale for certified gases. Measurement accuracy is typically expressed in terms of expanded measurement uncertainty (U_c), a combination of uncertainty sources such as:

- nonlinearity (lack of fit)
- cross-interference
- zero and span drift
- temperature
- flow rate
- pressure
- mains voltage

Measurement uncertainty for specific gases (CO, NO, NO_2, SO_2, HCl, HF, …) has a limit value proportional to emission limit value in the EU Industrial Emissions Directive, and the Gasmet system typically has measurement uncertainties smaller than one half the maximum uncertainty allowed for a certified (EN 15267-3, TÜV, MCERTS) emissions monitoring system. This ensures that Gasmet gas analyzers are capable of monitoring not only today's emission limits but also lower limit values that may be introduced in the future.

7. How are new gases added to the library?

New gases can be either measured with the instrument in question or imported from a generic library. The best method depends on the application; if traceability is required, instrument specific calibration is the best option, otherwise generic spectra may be used. Instrument specific calibration can be performed by the user or by the Gasmet calibration laboratory.

8. When should Gasmet™ FTIR Gas Analyzers be recalibrated?

FTIR gas analyzers do not require periodic recalibration. A daily background spectrum measurement with zero gas is enough to preserve measurement accuracy. Instead of periodic span calibrations, reference spectra for analysed gases are measured at the factory when the instrument is made and these do not drift.

Calibration of an FTIR instrument relies on:

- reference spectra recorded on a computer
- daily background spectrum measurement with zero gas (N2) which compensates for any variation in the IR source, sample cell, etc.
- continuous internal reference of wavelength scale with a reference laser

For the above reasons the response of an FTIR instrument does not drift and separate zero and span adjustments of each measured gas are not required. FTIR measures low ppm concentrations of pollutants in hot/wet gases up to 40 vol-% (400 000 ppm) water, so the reference spectra of H_2O are measured again after a service operation (involving the optical components) to preserve highest accuracy.

9. Why is the quality of the Interferometer crucial?

The Gasmet GICCOR (Genzel Interferometer with Cube Corner Retroreflectors) interferometer is specially designed for maximum optical throughput and maximum signal-to-noise ratio at a resolution of 7.72 cm^{-1} providing unparalleled stability with respect to vibration and temperature changes. It can be used in a temperature range of 0 to 40 °C (short term) and also in a person-portable analyzer while the user is moving with the instrument. The use of cube corner mirrors, a highly symmetric mirror layout and a patented moving mechanism removes temperature and vibration influence and the use of non-hygroscopic optical material removes the need for dry air or nitrogen purging of the interferometer

10. Why is the quality of the sample cell important?

The Gasmet sample cells have mirror surfaces machined directly to the cell end plates, eliminating a source of drift and uncertainty associated with adjustable mirror gas cells. The cell surfaces are coated with a proprietary combination of materials including Rhodium and Gold selected for their corrosion resistance against reactive gases and high IR reflectance (in the case of Gold). Sample cells are available in a very wide range of path lengths from 1cm to 980cm, and long path lengths are achieved in a small cell volume (450ml in the case of 980cm path). The cells are heated optionally up to 180 °C to allow hot/wet sampling of gases with high concentrations of H_2O, SO_2, etc.

11. Do acidic gases such as HCl and HF damage the sample cell?

The multiple layer coatings on the sample cell and elevated cell temperatures make the cell remarkably resistant to the corrosive effects of acid gases even when the water content of the gas is high. However, if the sample is allowed to cool down and condense inside the cell or the acid gas dew point exceeds cell temperature, damage to the cell is possible. For this reason the Gasmet sampling system design prevents the sample pump from pulling wet gas into a cell under the temperature set-point. If the temperature of any heated part falls below the set-point, or the system loses power, the cell is flushed with dry air or nitrogen before condensation can take place. As long as condensation is avoided the cell is not damaged by moderately high levels HCl or HF.

The corrosion resistance of the sample cell depends on the prevention of condensation inside the cell. The cell temperature should exceed the dew point of the sample gas by a safety margin. For this reason Gasmet analyzers have different temperature set points as shown in the table below:

Emission measurements with Fourier Transform Infrared Spectroscopy – Reference article list

Gasmet FTIR gas analyzers have been used for high-quality emission-related research already for more than a decade. Gasmet analyzers have been used to measure pollutants and greenhouse gases from e.g. waste incinerators and wastewater treatment plants as well as for catalyst research.

Calibration components

24.1.2022

#	Compound name	Formula	CAS number	Maximum range GAS-REF-001*	Maximum range GAS-REF-002**	Unit	Notes
	Typical components						
1	Water	H_2O	7732-18-5	40	60	vol-%	
2	Carbon dioxide	CO_2	124-38-9	30	100	vol-%	
3	Carbon monoxide	CO	630-08-0	1	30	vol-%	
4	Nitrous oxide	N_2O	10024-97-2	200	5000	ppm	
5	Methane	CH_4	74-82-8	1	50	vol-%	
	Open-chain hydrocarbons						
6	1,3-Butadiene	C_4H_6	106-99-0	200	1000	ppm	
7	1-Butene	C_4H_8	106-98-9	200	1000	ppm	
8	1-Heptene	C_7H_{14}	592-76-7	200	1000	ppm	
9	1-Hexyne	C_6H_{10}	693-02-7	NB	NB	ppm	
10	1-Nonene	C_9H_{18}	124-11-8	100	1000	ppm	
11	1-Octene	C_8H_{16}	111-66-0	100	1000	ppm	
12	1-Pentene	C_5H_{10}	109-67-1	200	1000	ppm	
13	2,2-Dimethylbutane	C_6H_{14}	75-83-2	NB	NB	ppm	
14	2,3,4-Trimethylpentane	C_8H_{18}	565-75-3	NB	NB	ppm	
15	2,3-Dimethylbutane	C_6H_{14}	79-29-8	NB	NB	ppm	
16	2,3-Dimethylpentane	C_7H_{16}	565-59-3	NB	NB	ppm	
17	2,4,4-Trimethyl-1-pentene	C_8H_{16}	107-39-1	NB	NB	ppm	
18	2,4,4-Trimethyl-2-pentene	C_8H_{16}	107-40-4	NB	NB	ppm	
19	2,4-Dimethylhexane	C_8H_{18}	589-43-5	NB	NB	ppm	
20	2,4-Dimethylpentane	C_7H_{16}	108-08-7	NB	NB	ppm	
21	2,5-Dimethylhexane	C_8H_{18}	592-13-2	NB	NB	ppm	
22	2-Methyl-1-butene	C_5H_{10}	563-46-2	NB	NB	ppm	
23	3-Methyl-1-butene	C_5H_{10}	563-45-1	NB	NB	ppm	
24	3-Methylhexane	C_7H_{16}	589-34-4	NB	NB	ppm	
25	3-Methylpentane	C_6H_{14}	96-14-0	NB	NB	ppm	
26	Acetylene (Ethyne)	C_2H_2	74-86-2	500	2000	ppm	
27	Butane	C_4H_{10}	106-97-8	200	1000	ppm	
28	Cetane (*n* -Hexadecane)	$C_{16}H_{34}$	544-76-3	NB	NB	ppm	Calibration only for heated analyzer.
29	cis-2-Butene	C_4H_8	590-18-1	NB	NB	ppm	
30	cis-2-Pentene	C_5H_{10}	627-20-3	NB	NB	ppm	
31	Decane	$C_{10}H_{22}$	124-18-5	100	500	ppm	
32	Dodecane	$C_{12}H_{26}$	112-40-3	100	500	ppm	
33	Ethane	C_2H_6	74-84-0	200	2000	ppm	
34	Ethylene (Ethene)	C_2H_4	74-85-1	200	2000	ppm	
35	Heptane	C_7H_{16}	142-82-5	200	1000	ppm	
36	Hexane	C_6H_{14}	110-54-3	200	1000	ppm	
37	Hexene	C_6H_{12}	592-41-6	200	1000	ppm	
38	Isobutane (2-Methyl propane)	C_4H_{10}	75-28-5	200	1000	ppm	
39	Isobutene (2-Methyl-1-propene)	C_4H_8	115-11-7	NB	NB	ppm	
40	Isoheptane	C_7H_{16}	591-76-4	NB	NB	ppm	
41	Isohexane (2-Methyl pentane)	C_6H_{14}	107-83-5	200	1000	ppm	
42	Iso-octane (2,2,4-Trimethyl pentane)	C_8H_{18}	540-84-1	100	500	ppm	
43	Isopentane (2-Methyl butane)	C_5H_{12}	78-78-4	200	1000	ppm	
44	Isopentene (2-Methyl-2-butene)	C_5H_{10}	513-35-9	200	1000	ppm	
45	Isoprene	C_5H_8	78-79-5	200	1000	ppm	
46	Nonane	C_9H_{20}	111-84-2	100	500	ppm	
47	Octane	C_8H_{18}	111-65-9	100	500	ppm	
48	Pentane	C_5H_{12}	109-66-0	200	1000	ppm	
49	Propane	C_3H_8	74-98-6	200	1000	ppm	
50	Propene	C_3H_6	115-07-1	200	1000	ppm	
51	Propyne	C_3H_4	74-99-7	NB	NB	ppm	
52	Tetradecane	$C_{14}H_{30}$	629-59-4	100	500	ppm	
53	trans-2-Butene	C_4H_8	624-64-6	NB	NB	ppm	
54	trans-2-Pentene	C_5H_{10}	646-04-8	NB	NB	ppm	
55	Tridecane	$C_{13}H_{28}$	629-50-5	100	500	ppm	
56	Undecane	$C_{11}H_{24}$	1120-21-4	100	500	ppm	
57	Vinylacetylene (1-Buten-3-yne)	C_4H_4	689-97-4	NB	NB	ppm	
	Aromatic or cyclic hydrocarbons						
58	(-)-trans-Caryophyllene	$C_{15}H_{24}$	87-44-5	NB	NB	ppm	
59	1,2,3-Trimethylbenzene	C_9H_{12}	526-73-8	200	1000	ppm	
60	1,2,4-Trimethylbenzene	C_9H_{12}	95-63-6	200	1000	ppm	
61	1,2,4-Trivinylcyclohexane	$C_{12}H_{18}$	2855-27-8	NB	NB	ppm	
62	1,3,5-Triisopropylbenzene	$C_{15}H_{24}$	717-74-8	NB	NB	ppm	
63	1,3,5-Trimethylbenzene (Mesitylene)	C_9H_{12}	108-67-8	200	1000	ppm	
64	1-Ethylnaphthalene	$C_{12}H_{12}$	1127-76-0	NB	NB	ppm	Only non-instrument specific references. Solid material.
65	1-Methylnaphthalene	$C_{11}H_{10}$	90-12-0	NB	NB	ppm	Only non-instrument specific references. Solid material.
66	2-Ethyltoluene	C_9H_{12}	611-14-3	200	1000	ppm	

67	2-Methylnaphthalene	$C_{11}H_{10}$	91-57-6	NB	NB	ppm	Only non-instrument specific references. Solid material.
68	2-Vinyltoluene (2-methylstyrene, o-methylstyrene)	C_9H_{10}	611-15-4	NB	NB	ppm	
69	3-Ethyltoluene	C_9H_{12}	620-14-4	200	1000	ppm	
70	3-Vinyltoluene (3-methylstyrene, m-methylstyrene)	C_9H_{10}	100-80-1	NB	NB	ppm	
71	4-Ethyltoluene	C_9H_{12}	622-96-8	200	1000	ppm	
72	4-tert-Butylstyrene	$C_{12}H_{16}$	1746-23-2	NB	NB	ppm	
73	4-Vinyl-1-cyclohexene	C_8H_{12}	100-40-3	NB	NB	ppm	
74	4-Vinyltoluene (4-methylstyrene, p-methylstyrene)	C_9H_{10}	622-97-9	NB	NB	ppm	
75	5-Ethylidene-2-norbornene (ENB)	C_9H_{12}	16219-75-3	NB	NB	ppm	
76	5-Vinyl-2-norbornene (VNB)	C_9H_{12}	3048-64-4	NB	NB	ppm	
77	Acenaphthene	$C_{12}H_{10}$	83-32-9	NB	NB	ppm	Only non-instrument specific references. Solid material.
78	Benzene	C_6H_6	71-43-2	200	1000	ppm	
79	Biphenyl	$C_{12}H_{10}$	92-52-4	NB	NB	ppm	
80	cis-1,4-Dimethylcyclohexane	C_8H_{16}	624-29-3	NB	NB	ppm	
81	Cumene	C_9H_{12}	98-82-8	200	1000	ppm	
82	Cyclohexane	C_6H_{12}	110-82-7	100	500	ppm	
83	Cyclopentane	C_5H_{10}	287-92-3	100	500	ppm	
84	Cyclopentene	C_5H_8	142-29-0	200	1000	ppm	
85	Cyclopropane (Trimethylene)	C_3H_6	75-19-4	NB	NB	ppm	
86	Delta-3-Carene	$C_{10}H_{16}$	13466-78-9	200	1000	ppm	
87	Dicyclopentadiene (DCPD)	$C_{10}H_{12}$	77-73-6	NB	NB	ppm	
88	Ethyl benzene	C_8H_{10}	100-41-4	500	2000	ppm	
89	Ethylcyclohexane	C_8H_{16}	1678-91-7	100	500	ppm	
90	Indene	C_9H_8	95-13-6	NB	NB	ppm	
91	Isopropylcyclohexane (Methylethylcyclohexane)	C_9H_{18}	696-29-7	NB	NB	ppm	
92	Limonene	$C_{10}H_{16}$	138-86-3	200	1000	ppm	
93	m-Diethylbenzene (1,3-diethylbenzene)	$C_{10}H_{14}$	141-93-5	100	500	ppm	
94	Methylcyclohexane	C_7H_{14}	108-87-2	100	500	ppm	
95	Methylcyclopentane	C_6H_{12}	96-37-7	100	500	ppm	
96	m-Xylene	C_8H_{10}	108-38-3	500	2000	ppm	
97	Naphthalene	$C_{10}H_8$	91-20-3	NB	NB	ppm	Only non-instrument specific references. Solid material.
98	o-Diethylbenzene (1,2-diethylbenzene)	$C_{10}H_{14}$	135-01-3	100	500	ppm	
99	o-Xylene	C_8H_{10}	95-47-6	500	2000	ppm	
100	p-Diethylbenzene (1,4-diethylbenzene)	$C_{10}H_{14}$	105-05-5	100	500	ppm	
101	Phenyl acetylene (1-Phenylethyne)	C_8H_6	536-74-3	200	1000	ppm	
102	Propylbenzene	C_9H_{12}	103-65-1	NB	NB	ppm	
103	p-Xylene	C_8H_{10}	106-42-3	500	2000	ppm	
104	Styrene	C_8H_8	100-42-5	500	2000	ppm	
105	Tetraline (1,2,3,4-Tetrahydronaphthalene; Bacticin; benzocyclohexan	$C_{10}H_{12}$	119-64-2	NB	NB	ppm	
106	Toluene	C_7H_8	108-88-3	200	2000	ppm	
107	trans-1,4-Dimethylcyclohexane	C_8H_{16}	2207-04-7	NB	NB	ppm	
108	α-Methylstyrene	C_9H_{10}	98-83-9	200	2000	ppm	
109	α-Pinene	$C_{10}H_{16}$	80-56-8	200	500	ppm	
110	β-Pinene	$C_{10}H_{16}$	127-91-3	200	500	ppm	
	Acids and derivatives						
111	1,4-Butanediol dimethacrylate (BDDMA)	$C_{12}H_{18}O_4$	2082-81-7	NB	NB	ppm	
112	1-Ethoxy-2-propyl acetate (2-Acetoxy-1-ethoxypropane)	$C_7H_{14}O_3$	54839-24-6	NB	NB	ppm	
113	1-Methoxy-2-propyl acetate	$C_6H_{12}O_3$	108-65-6	100	500	ppm	
114	2-(2-Butoxyethoxy)ethyl acetate	$C_{10}H_{20}O_4$	124-17-4	100	500	ppm	
115	2-Butoxyethyl acetate	$C_8H_{16}O_3$	112-07-2	100	500	ppm	
116	2-Ethoxyethyl acetate (Cellosolve acetate)	$C_6H_{12}O_3$	111-15-9	100	500	ppm	
117	2-Ethylhexyl acrylate	$C_{11}H_{20}O_2$	103-11-7	NB	NB	ppm	
118	2-Hydroxybutyl acetate	$C_6H_{12}O_3$	24469-20-3	NB	NB	ppm	
119	2-Methoxy-1-propyl acetate	$C_6H_{12}O_3$	70657-70-4	NB	NB	ppm	
120	2-Methoxyethyl acetate (Methyl cellosolve acetate)	$C_5H_{10}O_3$	110-49-6	100	500	ppm	
121	3-Methoxybutyl acetate	$C_7H_{14}O_3$	4435-53-4	NB	NB	ppm	
122	Acetic acid	$C_2H_4O_2$	64-19-7	200	500	ppm	
123	Acetic acid anhydride	$C_4H_6O_3$	108-24-7	100	200	ppm	
124	Acetoacetic ester (Ethyl acetoacetate)	$C_6H_{10}O_3$	141-97-9	NB	NB	ppm	
125	Acrylic acid	$C_3H_4O_2$	79-10-7	100	500	ppm	
126	Butyl acetate	$C_6H_{12}O_2$	123-86-4	100	500	ppm	
127	Butyl acrylate (2-propenoic acid butyl ester)	$C_7H_{12}O_2$	141-32-2	NB	NB	ppm	
128	Butyl butyrate (Butanoic acid butyl ester, Butyric acid butyl ester, But	$C_8H_{16}O_2$	109-21-7	NB	NB	ppm	
129	Butyl glycolate (Glycolic acid butyl ester)	$C_6H_{12}O_3$	7397-62-8	NB	NB	ppm	
130	Butyl lactate (Butyl 2-hydroxypropanoate)	$C_7H_{14}O_3$	138-22-7	NB	NB	ppm	
131	Butyric acid (butanoic acid)	$C_4H_8O_2$	107-92-6	NB	NB	ppm	
132	Citraconic acid (Methylmaleic acid)	$C_5H_6O_4$	498-23-7	NB	NB	ppm	
133	Di(ethylene glycol) dimethacrylate (DEGDMA)	$C_{12}H_{18}O_5$	2358-84-1	NB	NB	ppm	
134	Diethyl carbonate (Carbonic acid diethyl ester)	$C_5H_{10}O_3$	105-58-8	50	200	ppm	
135	Dimethyl adipate	$C_8H_{14}O_4$	627-93-0	NB	NB	ppm	
136	Dimethyl carbonate (DCM; Methyl carbonate)	$C_3H_6O_3$	616-38-6	50	200	ppm	
137	Dimethyl glutarate (Pentanedioic acid dimethyl ester)	$C_7H_{12}O_4$	1119-40-0	NB	NB	ppm	
138	Dimethyl succinate (Succinic acid dimethyl ester)	$C_6H_{10}O_4$	106-65-0	NB	NB	ppm	
139	Di-tert-butyl dicarbonate	$C_{10}H_{18}O_5$	24424-99-5	NB	NB	ppm	
140	Ethyl acetate	$C_4H_8O_2$	141-78-6	100	500	ppm	
141	Ethyl acrylate	$C_5H_8O_2$	140-88-5	NB	NB	ppm	

142	Ethyl formate	$C_3H_6O_2$	109-94-4	NB	NB	ppm	
143	Ethyl lactate (Ethyl *α*-hydroxypropionate)	$C_5H_{10}O_3$	97-64-3	100	500	ppm	
144	Ethyl methacrylate (Ethyl 2-methylpropenoate)	$C_6H_{10}O_2$	97-63-2	NB	NB	ppm	
145	Ethyl methyl carbonate (Methyl ethyl carbonate)	$C_4H_8O_3$	623-53-0	50	200	ppm	
146	Ethyl-3-ethoxypropionate	$C_7H_{14}O_3$	763-69-9	100	500	ppm	
147	Ethylene carbonate (1,3-Dioxolan-2-one)	$C_3H_4O_3$	96-49-1	NB	NB	ppm	Calibration only for heated analyzer.
148	Formic acid	CH_2O_2	64-18-6	200	500	ppm	
149	Furfuryl acetate	$C_7H_8O_3$	623-17-6	NB	NB	ppm	
150	Heptanoic acid	$C_7H_{14}O_2$	111-14-8	NB	NB	ppm	
151	Hexanoic acid (caproic acid)	$C_6H_{12}O_2$	142-62-1	NB	NB	ppm	
152	Hexyl acetate	$C_8H_{16}O_2$	142-92-7	NB	NB	ppm	
153	Isobutyl acetate	$C_6H_{12}O_2$	110-19-0	NB	NB	ppm	
154	Isobutyl formate (2-Methylpropyl formate)	$C_5H_{10}O_2$	542-55-2	NB	NB	ppm	
155	Isobutyl methacrylate	$C_8H_{14}O_2$	97-86-9	NB	NB	ppm	
156	Isooctyl acrylate	$C_{11}H_{20}O_2$	29590-42-9	NB	NB	ppm	
157	Isopentyl acetate	$C_7H_{14}O_2$	123-92-2	100	500	ppm	
158	Isopropyl acetate	$C_5H_{10}O_2$	108-21-4	100	500	ppm	
159	Isopropyl lactate	$C_6H_{12}O_3$	63697-00-7	NB	NB	ppm	
160	Isovaleric acid (3-Methylbutyric acid, Isopentanoic acid, Delphinic aci	$C_5H_{10}O_2$	503-74-2	NB	NB	ppm	
161	Lactic acid	$C_3H_6O_3$	50-21-5	NB	NB	ppm	
162	Methacrylic acid	$C_4H_6O_2$	79-41-4	NB	NB	ppm	
163	Methyl-3-methoxypropionate (3-Methoxypropanoic acid methyl ester	$C_5H_{10}O_3$	3852-09-3	NB	NB	ppm	
164	Methyl acetate	$C_3H_6O_2$	79-20-9	100	500	ppm	
165	Methyl acrylate	$C_4H_6O_2$	96-33-3	100	500	ppm	
166	Methyl formate	$C_2H_4O_2$	107-31-3	100	500	ppm	
167	Methyl methacrylate	$C_5H_8O_2$	80-62-6	100	500	ppm	
168	Methyl valerate (Pentanoic acid methyl ester)	$C_6H_{12}O_2$	624-24-8	NB	NB	ppm	
169	Pentyl acetate (Banana oil)	$C_7H_{14}O_2$	628-63-7	100	500	ppm	
170	Propionic acid	$C_3H_6O_2$	79-09-4	100	500	ppm	
171	Propyl acetate	$C_5H_{10}O_2$	109-60-4	100	500	ppm	
172	Propylene carbonate (4-Methyl-1,3-dioxolan-2-one)	$C_4H_6O_3$	108-32-7	NB	NB	ppm	
173	tert-Butyl acetate	$C_6H_{12}O_2$	540-88-5	NB	NB	ppm	
174	trans-2-Hexenyl acetate	$C_8H_{14}O_2$	2497-18-9	NB	NB	ppm	
175	Valeric acid (Pentanoic acid)	$C_5H_{10}O_2$	109-52-4	NB	NB	ppm	
176	Vinyl acetate	$C_4H_6O_2$	108-05-4	100	500	ppm	
177	Vinylene carbonate (1,3-Dioxol-2-one)	$C_3H_2O_3$	872-36-6	NB	NB	ppm	Calibration only for heated analyzer.
	Aldehydes						
178	2-Ethyl-2-hexenal	$C_8H_{14}O$	645-62-5	NB	NB	ppm	
179	2-Ethylacrolein (2-Ethylacrylaldehyde)	C_5H_8O	922-63-4	NB	NB	ppm	
180	2-Ethylhexylaldehyde (2-Ethylhexanal)	$C_8H_{16}O$	123-05-7	200	1000	ppm	
181	2-Methylbutylaldehyde	$C_5H_{10}O$	96-17-3	NB	NB	ppm	
182	5-Hydroxymethyl-2-furfural (5-Hydroxymethyl-2-furaldehyde)	$C_6H_6O_3$	67-47-0	NB	NB	ppm	
183	5-Methylfurfural (5-Methyl-2-furaldehyde)	$C_6H_6O_2$	620-02-0	100	500	ppm	
184	Acetaldehyde	C_2H_4O	75-07-0	200	1000	ppm	
185	Acrolein (Acrylic aldehyde)	C_3H_4O	107-02-8	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
186	Benzaldehyde	C_7H_6O	100-52-7	NB	NB	ppm	
187	Butylaldehyde (Butanal)	C_4H_8O	123-72-8	200	1000	ppm	
188	Citronellal	$C_{10}H_{18}O$	106-23-0	NB	NB	ppm	
189	Crotonaldehyde	C_4H_6O	4170-30-3	NB	NB	ppm	
190	Formaldehyde	CH_2O	50-00-0	NB	NB	ppm	Maximum calibration 500ppm.
191	Furfural (2-Furaldehyde)	$C_5H_4O_2$	98-01-1	200	1000	ppm	
192	Glutaraldehyde	$C_5H_8O_2$	111-30-8	NB	NB	ppm	
193	Hexanal (Hexanaldehyde)	$C_6H_{12}O$	66-25-1	100	500	ppm	
194	Isobutyraldehyde (2-Methylpropanal)	C_4H_8O	78-84-2	200	1000	ppm	
195	Isovaleraldehyde	$C_5H_{10}O$	590-86-3	NB	NB	ppm	
196	Methacrylaldehyde (2-Methyl-2-propenal)	C_4H_6O	78-85-3	200	1000	ppm	
197	Nonanal	$C_9H_{18}O$	124-19-6	NB	NB	ppm	
198	Octanal (Caprylic aldehyde)	$C_8H_{16}O$	124-13-0	100	500	ppm	
199	o-Phthaldehyde (OPA)	$C_8H_6O_2$	643-79-8	NB	NB	ppm	Only non-instrument specific references.
200	o-Tolualdehyde	C_8H_8O	529-20-4	200	1000	ppm	
201	Pentanal (Pentanaldehyde; Valeraldehyde; Valeric aldehyde)	$C_5H_{10}O$	110-62-3	NB	NB	ppm	
202	Propionaldehyde (Propanal)	C_3H_6O	123-38-6	200	1000	ppm	
203	trans-2-Nonenal	$C_9H_{16}O$	18829-56-6	NB	NB	ppm	
	Ketones						
204	2,3-Butanedione (Diacetyl)	$C_4H_6O_2$	431-03-8	NB	NB	ppm	
205	2,3-Heptanedione	$C_7H_{12}O_2$	96-04-8	NB	NB	ppm	
206	2,3-Hexanedione	$C_6H_{10}O_2$	3848-24-6	NB	NB	ppm	
207	2,3-Pentanedione	$C_5H_8O_2$	600-14-6	NB	NB	ppm	
208	2,6-Dimethyl-4-heptanone	$C_9H_{18}O$	108-83-8	NB	NB	ppm	
209	2-Acetylfurane (2-Furyl methyl ketone)	$C_6H_6O_2$	1192-62-7	NB	NB	ppm	
210	2-Methylcyclohexanone	$C_7H_{12}O$	583-60-8	NB	NB	ppm	
211	2-Nonanone (Heptyl methyl ketone)	$C_9H_{18}O$	821-55-6	NB	NB	ppm	
212	4-Heptanone (Dipropyl ketone, Butyrone, DPK, Propyl ketone)	$C_7H_{14}O$	123-19-3	NB	NB	ppm	
213	4-Hydroxy-4-methyl-2-pentanone (Diacetone alcohol)	$C_6H_{12}O_2$	123-42-2	NB	NB	ppm	
214	4-Methyl-3-penten-2-one (Mesityl oxide)	$C_6H_{10}O$	141-79-7	NB	NB	ppm	
215	5-methyl-2-hexanone (MIAK; methyl isoamyl ketone)	$C_7H_{14}O$	110-12-3	NB	NB	ppm	

216	Acetoin (3-hydroxybutanone)	$C_4H_8O_2$	513-86-0	NB	NB	ppm	
217	Acetone	C_3H_6O	67-64-1	200	1000	ppm	
218	Acetophenone (Phenyl methyl ketone)	C_8H_8O	98-86-2	100	500	ppm	
219	Benzyl Methyl Ketone	$C_9H_{10}O$	103-79-7	NB	NB	ppm	
220	Carvone	$C_{10}H_{14}O$	2244-16-8	NB	NB	ppm	
221	Cyclohexanone (Cyclohexyl ketone)	$C_6H_{10}O$	108-94-1	100	500	ppm	
222	Cyclopentanone	C_5H_8O	120-92-3	NB	NB	ppm	
223	Diethyl ketone (DEK; 3-Pentanone)	$C_5H_{10}O$	96-22-0	200	1000	ppm	
224	Diketene (4-methylideneoxetan-2-one , γ-methylenebutyrolactone)	$C_4H_4O_2$	674-82-8	NB	NB	ppm	
225	Isophorone (3,5,5-Trimethyl-2-cyclohexene-1-one, Isoforone, Isoacetc	$C_9H_{14}O$	78-59-1	NB	NB	ppm	
226	Menthone	$C_{10}H_{18}O$	3391-87-5	NB	NB	ppm	
227	Methyl butyl ketone (MBK; 2-Hexanone)	$C_6H_{12}O$	591-78-6	200	1000	ppm	
228	Methyl ethyl ketone (MEK, 2-butanone)	C_4H_8O	78-93-3	200	1000	ppm	
229	Methyl isobutyl ketone (MIBK; 4-Methyl-2-pentanone)	$C_6H_{12}O$	108-10-1	200	1000	ppm	
230	Methyl pentyl ketone (2-Heptanone)	$C_7H_{14}O$	110-43-0	200	1000	ppm	
231	Methyl propyl ketone (2-Pentanone)	$C_5H_{10}O$	107-87-9	200	1000	ppm	
232	Methyl vinyl ketone (3-Buten-2-one)	C_4H_6O	78-94-4	NB	NB	ppm	
	Alcohols						
233	1-(2-Butoxypropoxy)propan-2-ol	$C_{10}H_{22}O_3$	24083-03-2	NB	NB	ppm	
234	1,2-Propanediol (propylene glycol)	$C_3H_8O_2$	57-55-6	200	1000	ppm	
235	1,3-Butanediol	$C_4H_{10}O_2$	107-88-0	200	1000	ppm	
236	1,4-Butanediol (1,4-Dihydroxybutane)	$C_4H_{10}O_2$	110-63-4	NB	NB	ppm	
237	1-Butanol	$C_4H_{10}O$	71-36-3	200	1000	ppm	
238	1-Butoxy-2-propanol (1,2-Propylene glycol 1-monobutyl ether)	$C_7H_{16}O_2$	5131-66-8	200	1000	ppm	
239	1-Ethoxy-2-propanol	$C_5H_{12}O_2$	1569-02-4	NB	NB	ppm	
240	1-Heptanol	$C_7H_{16}O$	111-70-6	NB	NB	ppm	
241	1-Hexanol	$C_6H_{14}O$	111-27-3	NB	NB	ppm	
242	1-Pentanol (Amyl alcohol)	$C_5H_{12}O$	71-41-0	200	1000	ppm	
243	1-Propanol	C_3H_8O	71-23-8	200	1000	ppm	
244	1-Propoxy-2-propanol (Propylene glycol *n*-propyl ether)	$C_6H_{14}O_2$	1569-01-3	100	500	ppm	
245	2-Butanol (*sec*-Butyl alcohol)	$C_4H_{10}O$	78-92-2	200	1000	ppm	
246	2-Ethoxyethanol (Cellosolve)	$C_4H_{10}O_2$	110-80-5	100	500	ppm	
247	2-Ethylhexanol (2-EH; 2-Ethylhexan-1-ol)	$C_8H_{18}O$	104-76-7	NB	NB	ppm	
248	2-Methoxyethanol (methyl cellosolve)	$C_3H_8O_2$	109-86-4	100	500	ppm	
249	2-Methoxy-1-propanol (2-methoxypropanol)	$C_4H_{10}O_2$	1589-47-5	NB	NB	ppm	
250	2-Methyl-1-butanol	$C_5H_{12}O$	137-32-6	NB	NB	ppm	
251	2-Methyl-2-butanol	$C_5H_{12}O$	75-85-4	NB	NB	ppm	
252	4-Methoxy-1-butanol (Butylene glycol methyl ether)	$C_5H_{12}O_2$	111-32-0	NB	NB	ppm	
253	4-Methyl-2-pentanol	$C_6H_{14}O$	108-11-2	NB	NB	ppm	
254	Allylalcohol	C_3H_6O	107-18-6	NB	NB	ppm	
255	Benzylalcohol	C_7H_8O	100-51-6	200	1000	ppm	Calibration for heated analyzer only.
256	cis-3-Hexen-1-ol (leaf alcohol)	$C_6H_{12}O$	928-96-1	NB	NB	ppm	
257	Cyclohexanol	$C_6H_{12}O$	108-93-0	NB	NB	ppm	
258	Diethylene glycol (DEG)	$C_4H_{10}O_3$	111-46-6	NB	NB	ppm	
259	Diethylene glycol monoethyl ether acetate	$C_8H_{16}O_4$	112-15-2	100	500	ppm	
260	Diethylene glycol monomethyl ether (MDGE, 2-(2-Methoxyethoxy)eth	$C_5H_{12}O_3$	111-77-3	NB	NB	ppm	
261	Ethanol	C_2H_6O	64-17-5	500	2000	ppm	
262	Ethylene glycol (1,2-Ethanediol)	$C_2H_6O_2$	107-21-1	200	1000	ppm	
263	Furfuryl alcohol (2-Furan methanol)	$C_5H_6O_2$	98-00-0	200	1000	ppm	
264	Glycerol (1,2,3-Propanetriol)	$C_3H_8O_3$	56-81-5	NB	NB	ppm	
265	Isobutanol (2-Methyl-1-propanol)	$C_4H_{10}O$	78-83-1	200	1000	ppm	
266	Isoeugenol (2-Methoxy-4-propenylphenol)	$C_{10}H_{12}O_2$	97-54-1	NB	NB	ppm	
267	Isopentyl alcohol (Isoamyl alcohol; Isopentanol; 3-Methyl-1-butanol)	$C_5H_{12}O$	123-51-3	200	1000	ppm	
268	Isopropanol (2-Propanol; Isopropyl alcohol)	C_3H_8O	67-63-0	200	1000	ppm	
269	Linalool (3,7-Dimethyl-1,6-octadien-3-ol)	$C_{10}H_{18}O$	78-70-6	NB	NB	ppm	
270	m-Cresol (3-Methyl phenol)	C_7H_8O	108-39-4	200	1000	ppm	
271	Menthol (2-Isopropyl-5-methylcyclohexanol, Hexahydrothymol)	$C_{10}H_{20}O$	1490-04-6	NB	NB	ppm	
272	Methanol	CH_4O	67-56-1	500	2000	ppm	
273	o-Cresol (2-Methyl phenol)	C_7H_8O	95-48-7	200	1000	ppm	
274	p-Cresol (4-Methyl phenol)	C_7H_8O	106-44-5	200	1000	ppm	
275	Phenol	C_6H_6O	108-95-2	200	1000	ppm	
276	Pinacolyl alcohol (3,3-Dimethyl-2-butanol)	$C_6H_{14}O$	464-07-3	200	1000	ppm	
277	Propargyl alcohol	C_3H_4O	107-19-7	NB	NB	ppm	
278	t-Butanol (1,1-Dimethyl ethanol)	$C_4H_{10}O$	75-65-0	200	1000	ppm	
279	Terpinen-4-ol [4-Methyl-1-(1-methylethyl)-3-cyclohexen-1-ol]	$C_{10}H_{18}O$	562-74-3	200	1000	ppm	
280	Terpineol	$C_{10}H_{18}O$	8000-41-7	200	1000	ppm	
281	Triethylene glycol (TEG)	$C_6H_{14}O_4$	112-27-6	NB	NB	ppm	Calibration for heated analyzer only.
	Ethers						
282	1,2-Dimethoxyethane (Ethylene glycol dimethyl ether)	$C_4H_{10}O_2$	110-71-4	100	500	ppm	
283	1,3-Dimethoxy-2-hydroxybenzene (Syringol)	$C_8H_{10}O_3$	91-10-1	NB	NB	ppm	
284	1,3-Dioxane (trimethylene glycol methylene ether)	$C_4H_8O_2$	505-22-6	NB	NB	ppm	
285	1,3-Dioxolane (1,3-Dioxacyclopentane)	$C_3H_6O_2$	646-06-0	NB	NB	ppm	
286	1,4-Butanediol vinyl ether	$C_6H_{12}O_2$	17832-28-9	NB	NB	ppm	
287	2,2-Dimethoxypropane	$C_5H_{12}O_2$	77-76-9	100	500	ppm	
288	2-Methoxyphenol (Guaiacol)	$C_7H_8O_2$	90-05-1	NB	NB	ppm	
289	Anisole (Methoxybenzene)	C_7H_8O	100-66-3	100	500	ppm	

290	Butyl methyl ether	$C_5H_{12}O$	628-28-4	NB	NB	ppm	
291	Di(ethylene glycol) ethyl ether (2-(2-Ethoxyethoxy)ethanol	$C_6H_{14}O_3$	111-90-0	NB	NB	ppm	
292	Dibutyl ether	$C_8H_{18}O$	142-96-1	NB	NB	ppm	
293	Diethyl ether (Ethoxy ethane)	$C_4H_{10}O$	60-29-7	100	500	ppm	
294	Diethylene glycol butyl ether [2-(2-Butoxyethoxy)ethanol]	$C_8H_{18}O_3$	112-34-5	100	500	ppm	Calibration for heated analyzer only.
295	Diethylene glycol dimethyl ether (Diglyme)	$C_6H_{14}O_3$	111-96-6	NB	NB	ppm	
296	Diisopropyl ether	$C_6H_{14}O$	108-20-3	100	500	ppm	
297	Dimethoxymethane (Methylene dimethyl ether; Methylal)	$C_3H_8O_2$	109-87-5	100	500	ppm	
298	Diphenyl ether	$C_{12}H_{10}O$	101-84-8	NB	NB	ppm	
299	Dipropylene glycol dimethyl ether	$C_8H_{18}O_3$	89399-28-0	NB	NB	ppm	
300	Dipropylene glycol monomethyl ether	$C_7H_{16}O_3$	34590-94-8	NB	NB	ppm	
301	Ethyl tert-butyl ether (ETBE; 2-Ethoxy-2-methyl-propane)	$C_6H_{14}O$	637-92-3	NB	NB	ppm	
302	Ethyl vinyl ether	C_4H_8O	109-92-2	100	500	ppm	
303	Ethylene glycol monobutyl ether (2-Butoxyethanol)	$C_6H_{14}O_2$	111-76-2	100	500	ppm	
304	Ethylene glycol monoisopropyl ether (2-Isopropoxyethanol)	$C_5H_{12}O_2$	109-59-1	NB	NB	ppm	
305	Eucalyptol (1,8-Cineole; 1,8-Epoxy-p-menthane; 1,3,3-Trimethyl-2-oxat	$C_{10}H_{18}O$	470-82-6	NB	NB	ppm	
306	Isosafrole	$C_{10}H_{10}O_2$	120-58-1	NB	NB	ppm	
307	Methyl ether (Dimethyl ether)	C_2H_6O	115-10-6	NB	NB	ppm	
308	Methyl salicylate (2-Hydroxybenzoic acid methyl ester)	$C_8H_8O_3$	119-36-8	100	500	ppm	
309	Methyl tert-butyl ether (MTBE; 2-Methoxy-2-methyl propane)	$C_5H_{12}O$	1634-04-4	100	500	ppm	
310	p-Dioxane (Glycol ethylene ether; 1,4-Dioxane)	$C_4H_8O_2$	123-91-1	100	500	ppm	
311	Tert-amyl methyl ether (TAME; 2-methoxy-2-methylbutane)	$C_6H_{14}O$	994-05-8	NB	NB	ppm	
312	α-Propylene glycol monomethyl ether (1-Methoxy-2-propanol)	$C_4H_{10}O_2$	107-98-2	100	500	ppm	
	Epoxy compounds						
313	2,5-Dimethylfuran	C_6H_8O	625-86-5	NB	NB	ppm	
314	2-Methylfuran	C_5H_6O	534-22-5	NB	NB	ppm	
315	Ethylene oxide (Oxirane; Epoxyethane)	C_2H_4O	75-21-8	NB	NB	ppm	
316	Furan (Furfuran)	C_4H_4O	110-00-9	200	1000	ppm	
317	Maleic anhydride	$C_4H_2O_3$	108-31-6	NB	NB	ppm	
318	Propylene oxide (Methyl oxirane; Epoxypropane)	C_3H_6O	75-56-9	200	1000	ppm	
319	Tetrahydrofuran (THF; 1,4-Epoxybutane)	C_4H_8O	109-99-9	200	1000	ppm	
	Sulfur compounds						
320	1,2-Ethanedithiol (1,2-Dimercaptoethane Dithioglycol Ethylene merca	$C_2H_6S_2$	540-63-6	NB	NB	ppm	
321	1-Butanethiol (Butyl mercaptan)	$C_4H_{10}S$	109-79-5	NB	NB	ppm	
322	2-Methylthiophene	C_5H_6S	554-14-3	NB	NB	ppm	
323	3-(Methylthio)propionaldehyde (3-Methylsulfanyl-propionaldehyde)	C_4H_8OS	3268-49-3	NB	NB	ppm	
324	3-Mercaptopropionic acid	$C_3H_6O_2S$	107-96-0	NB	NB	ppm	
325	Benzenethiol (Phenylthiol; Thiophenol)	C_6H_6S	108-98-5	NB	NB	ppm	
326	Carbon disulfide	CS_2	75-15-0	50	200	ppm	
327	Carbonyl sulfide	COS	463-58-1	NB	NB	ppm	
328	Diethyl sulfate (Sulfuric acid diethyl ester)	$C_4H_{10}O_4S$	64-67-5	NB	NB	ppm	
329	Dimethyl disulfide (DMDS)	$C_2H_6S_2$	624-92-0	200	1000	ppm	
330	Dimethyl sulfate (DMSO4; Sulfuric acid dimethyl ester)	$C_2H_6O_4S$	77-78-1	NB	NB	ppm	
331	Dimethyl sulfide (DMS)	C_2H_6S	75-18-3	200	1000	ppm	
332	Dimethyl sulfoxide	C_2H_6OS	67-68-5	100	500	ppm	
333	Ethylmercaptan (Ethanethiol)	C_2H_6S	75-08-1	100	500	ppm	
334	Mercaptoacetic acid (Thioglycolic acid)	$C_2H_4O_2S$	68-11-1	NB	NB	ppm	
335	Methylmercaptan (Methanethiol)	CH_4S	74-93-1	NB	NB	ppm	
336	Tetrahydrothiophene (Tetramethylene sulfide)	C_4H_8S	110-01-0	NB	NB	ppm	
337	Thiophene (Thiacyclopentadiene)	C_4H_4S	110-02-1	NB	NB	ppm	
	Nitrogen compounds						
338	(-)-Nicotine	$C_{10}H_{14}N_2$	54-11-5	NB	NB	ppm	
339	1,1-Dimethylhydrazine (Dimazine)	$C_2H_8N_2$	57-14-7	NB	NB	ppm	
340	1-(2-Aminoethyl)piperazine	$C_6H_{15}N_3$	140-31-8	NB	NB	ppm	
341	1,3-Dimethyl-2-imidazolidinone (N,N'-Dimethylethyleneurea)	$C_5H_{10}N_2O$	80-73-9	NB	NB	ppm	
342	1,4-Diaminobutane (Tetramethylenediamine, 1.4-Butanediamine)	$C_4H_{12}N_2$	110-60-1	NB	NB	ppm	
343	1,6-Hexamethylene diisocyanate	$C_8H_{12}N_2O_2$	822-06-0	NB	NB	ppm	
344	1-Formylpiperazine (1-Piperazinecarboxaldehyde)	$C_5H_{10}N_2O$	7755-92-2	NB	NB	ppm	
345	1-Methyl-2-pyrrolidinone	C_5H_9NO	872-50-4	NB	NB	ppm	
346	1-Methylimidazol	$C_4H_6N_2$	616-47-7	NB	NB	ppm	
347	1-Vinyl-2-pyrrolidinone (N-vinyl-2-pyrrolidinone)	C_6H_9NO	88-12-0	NB	NB	ppm	
348	2-(2-Aminoethoxy)ethanol (Diethylene glycol amine)	$C_4H_{11}NO_2$	929-06-6	NB	NB	ppm	
349	2-(Ethylamino)ethanol (EMEA; N-Ethylethanolamine)	$C_4H_{11}NO$	110-73-6	NB	NB	ppm	
350	2,3-Dimethylpyrazine	$C_6H_8N_2$	5910-89-4	NB	NB	ppm	
351	2,4,6-Trimethylpyridine	$C_8H_{11}N$	108-75-8	NB	NB	ppm	
352	2,4-Toluene diisocyanate	$C_9H_6N_2O_2$	584-84-9	NB	NB	ppm	
353	2,5-Dimethylpyrazine	$C_6H_8N_2$	123-32-0	NB	NB	ppm	
354	2,6-Diethylaniline	$C_{10}H_{15}N$	579-66-8	NB	NB	ppm	
355	2,6-Dimethylpyrazine	$C_6H_8N_2$	108-50-9	NB	NB	ppm	
356	2-Amino-1-butanol	$C_4H_{11}NO$	96-20-8	200	1000	ppm	
357	2-Amino-2-methylpropanol (β-Aminoisobutyl alcohol, AMP)	$C_4H_{11}NO$	124-68-5	NB	NB	ppm	
358	2-Dimethylaminoethanol (N,N-Dimethyl-2-hydroxyethylamine, N,N-Din	$C_4H_{11}NO$	108-01-0	NB	NB	ppm	
359	2-Ethyl-6-methylaniline	$C_9H_{13}N$	24549-06-2	NB	NB	ppm	
360	2-Methylaminoethanol (N-Methylethanolamine)	C_3H_9NO	109-83-1	NB	NB	ppm	
361	2-Methylpyrazine	$C_5H_6N_2$	109-08-0	NB	NB	ppm	
362	2-Methylpyridine (α-Picoline)	C_6H_7N	109-06-8	NB	NB	ppm	

363	3-Amino-1-propanol	C_3H_9NO	156-87-6	NB	NB	ppm	
364	3-Methylpyridine	C_6H_7N	108-99-6	NB	NB	ppm	
365	3-Picolyamine (3-(Aminomethyl)pyridine)	$C_6H_8N_2$	3731-52-0	NB	NB	ppm	
366	3-Pyridinecarboxaldehyde (Nicotinaldehyde)	C_6H_5NO	500-22-1	NB	NB	ppm	
367	4,N,N-Trimethylaniline	$C_9H_{13}N$	99-97-8	NB	NB	ppm	
368	Acetone cyanohydrin	C_4H_7NO	75-86-5	NB	NB	ppm	
369	Acetonitrile	C_2H_3N	75-05-8	NB	NB	ppm	
370	Acrylonitrile	C_3H_3N	107-13-1	200	1000	ppm	
371	Allylcyanide (3-Butenenitrile)	C_4H_5N	109-75-1	NB	NB	ppm	
372	Aniline (Benzenamine)	C_6H_7N	62-53-3	200	1000	ppm	
373	Benzonitrile (Phenyl cyanide)	C_7H_5N	100-47-0	NB	NB	ppm	
374	Benzylamine (α-Aminotoluene)	C_7H_9N	100-46-9	NB	NB	ppm	
375	Butyl isocyanate (1-Isocyanatobutane)	C_5H_9NO	111-36-4	NB	NB	ppm	
376	Butylamine (1-Butanamine)	$C_4H_{11}N$	109-73-9	200	1000	ppm	
377	Cyanogen (Dicyan)	C_2N_2	460-19-5	NB	NB	ppm	
378	Cyclohexylamine	$C_6H_{13}N$	108-91-8	NB	NB	ppm	
379	Dibutylamine	$C_8H_{19}N$	111-92-2	NB	NB	ppm	
380	Diethanolamine (DEA; 2,2'-Iminodiethanol, Bis(2-hydroxyethyl)amine)	$C_4H_{11}NO_2$	111-42-2	NB	NB	ppm	
381	Diethylamine	$C_4H_{11}N$	109-89-7	200	1000	ppm	
382	Diethylaminoethanol [2-(Diethylamino)-ethanol]	$C_6H_{15}NO$	100-37-8	200	1000	ppm	
383	Diethylenetriamine	$C_4H_{13}N_3$	111-40-0	100	500	ppm	
384	Dihexylamine	$C_{12}H_{27}N$	143-16-8	NB	NB	ppm	
385	Dimethylacetamide	C_4H_9NO	127-19-5	200	1000	ppm	
386	Dimethylamine	C_2H_7N	124-40-3	NB	NB	ppm	
387	Dimethylformamide (DMF)	C_3H_7NO	68-12-2	200	1000	ppm	
388	Ethanolamine (2-Aminoethanol; MEA)	C_2H_7NO	141-43-5	200	1000	ppm	
389	Ethylamine (1-Ethanamine)	C_2H_7N	75-04-7	NB	NB	ppm	
390	Ethylenediamine (Ethane-1,2-diamine)	$C_2H_8N_2$	107-15-3	100	500	ppm	
391	Ethylmorpholine	$C_6H_{13}NO$	100-74-3	NB	NB	ppm	
392	Hexylamine	$C_6H_{15}N$	111-26-2	NB	NB	ppm	
393	Hydrogen cyanide	HCN	74-90-8	100	500	ppm	
394	Isocyanic acid (Hydrogen isocyanate)	HNCO	75-13-8	NB	NB	ppm	Only non-instrument specific references.
395	Isopropyl isocyanate (1-Methylethyl isocyanate, 2-Isocyanatopropane	C_4H_7NO	1795-48-8	200	1000	ppm	
396	Isopropylamine (2-Propanamine)	C_3H_9N	75-31-0	200	1000	ppm	
397	Methacrylonitrile	C_4H_5N	126-98-7	NB	NB	ppm	
398	Methyl diethanolamine (MDEA)	$C_5H_{13}NO_2$	105-59-9	100	500	ppm	
399	Methyl isocyanate (Isocyanatomethane)	C_2H_3NO	624-83-9	NB	NB	ppm	
400	Methylamine	CH_5N	74-89-5	NB	NB	ppm	
401	Morpholine	C_4H_9NO	110-91-8	200	1000	ppm	
402	N,N-Diethylmethylamine (N-Methyldiethylamine)	$C_5H_{13}N$	616-39-7	NB	NB	ppm	
403	N,N-Dimethylaniline	$C_8H_{11}N$	121-69-7	100	500	ppm	
404	N,N-Dimethylethylamine (N-Ethyldimethylamine, DMEA)	$C_4H_{11}N$	598-56-1	NB	NB	ppm	
405	N,N-Dimethylisopropylamine (N,N-Dimethyl-2-propanamine)	$C_5H_{13}N$	996-35-0	NB	NB	ppm	
406	Nitrobenzene	$C_6H_5NO_2$	98-95-3	200	1000	ppm	
407	Nitroethane	$C_2H_5NO_2$	79-24-3	200	1000	ppm	
408	Nitromethane	CH_3NO_2	75-52-5	200	1000	ppm	
409	N-Methyl-1,3-diaminopropane (MAPA; 3-(Methylamino)propylamine; I	$C_4H_{12}N_2$	6291-84-5	NB	NB	ppm	
410	n-Methylmorpholine (4-Methylmorpholine)	$C_5H_{11}NO$	109-02-4	200	1000	ppm	
411	o-Nitrotoluene	$C_7H_7NO_2$	88-72-2	NB	NB	ppm	
412	o-Toluidine (2-Aminotoluene; 2-Methylbenzenamine)	C_7H_9N	95-53-4	NB	NB	ppm	
413	Phenyl isocyanate (Carbanil; Phenylcarbimide)	C_7H_5NO	103-71-9	NB	NB	ppm	
414	Phenyl isothiocyanate (Isothiocyanatobenzene)	C_7H_5NS	103-72-0	NB	NB	ppm	
415	Piperazine (Diethylenediamine; Hexahydropyrazine)	$C_4H_{10}N_2$	110-85-0	NB	NB	ppm	
416	Piperidine	$C_5H_{11}N$	110-89-4	200	1000	ppm	
417	Propanenitrile	C_3H_5N	107-12-0	NB	NB	ppm	
418	Propylamine (1-Aminopropane)	C_3H_9N	107-10-8	200	1000	ppm	
419	Pyridine	C_5H_5N	110-86-1	100	500	ppm	
420	Pyrrolidine (Azacyclopentane)	C_4H_9N	123-75-1	200	1000	ppm	
421	tert-Butylamine (2-Methyl-2-propanamine)	$C_4H_{11}N$	75-64-9	NB	NB	ppm	
422	Tetraethylurea (1,1,3,3-Tetraethylurea)	$C_9H_{20}N_2O$	1187-03-7	NB	NB	ppm	
423	Tetramethylurea (1,1,3,3-Tetramethylurea)	$C_5H_{12}N_2O$	632-22-4	NB	NB	ppm	
424	Triethanolamine	$C_6H_{15}NO_3$	102-71-6	NB	NB	ppm	
425	Triethylamine	$C_6H_{15}N$	121-44-8	NB	NB	ppm	
426	Trimethylamine	C_3H_9N	75-50-3	NB	NB	ppm	
	Chloro compounds (see also freons)						
427	1,1,1-Trichloroethane	$C_2H_3Cl_3$	71-55-6	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
428	1,1,2,2-Tetrachloroethane	$C_2H_2Cl_4$	79-34-5	200	1000	ppm	
429	1,1,2-Trichloroethane	$C_2H_3Cl_3$	79-00-5	200	1000	ppm	
430	1,1-Dichloroethane	$C_2H_4Cl_2$	75-34-3	200	1000	ppm	
431	1,2,3-Trichloropropane	$C_3H_5Cl_3$	96-18-4	200	1000	ppm	
432	1,2,4-Trichlorobenzene	$C_6H_3Cl_3$	120-82-1	NB	NB	ppm	
433	1,2-Dichlorobenzene (*o*-Dichlorobenzene)	$C_6H_4Cl_2$	95-50-1	200	1000	ppm	
434	1,2-Dichloroethane (Freon 150)	$C_2H_4Cl_2$	107-06-2	200	1000	ppm	
435	1,2-Dichloropropane (Propylene dichloride)	$C_3H_6Cl_2$	78-87-5	200	1000	ppm	
436	1,3-Dichloro-2-propanol	$C_3H_6Cl_2O$	96-23-1	NB	NB	ppm	
437	1,3-Dichlorobenzene	$C_6H_4Cl_2$	541-73-1	NB	NB	ppm	
438	1,3-Dichloropropane	$C_3H_6Cl_2$	142-28-9	NB	NB	ppm	

439	1,4-Dichlorobenzene (*p* -Dichlorobenzene)	$C_6H_4Cl_2$	106-46-7	NB	NB	ppm	
440	2,3-Dichloro-1-propanol	$C_3H_6Cl_2O$	616-23-9	NB	NB	ppm	
441	2,5-Dichlorophenol	$C_6H_4Cl_2O$	583-78-8	NB	NB	ppm	
442	2-Chloroethanol	C_2H_5ClO	107-07-3	NB	NB	ppm	
443	3-Chloro-2-methyl-1-propene (Methallyl chloride)	C_4H_7Cl	563-47-3	NB	NB	ppm	
444	3-Chloropropionyl chloride (3-Chloropropionic acid chloride; 3-Chloro	$C_3H_4Cl_2O$	625-36-5	NB	NB	ppm	
445	3-Chlorotoluene (1-Chloro-3-methylbenzene)	C_7H_7Cl	108-41-8	200	1000	ppm	
446	Acetyl chloride (Acetic chloride)	C_2H_3ClO	75-36-5	200	1000	ppm	
447	Allyl chloride (3-chloro-1-propene)	C_3H_5Cl	107-05-1	200	1000	ppm	
448	Benzyl chloride (*α* -Chlorotoluene)	C_7H_7Cl	100-44-7	200	1000	ppm	
449	Bis(trichloromethyl) carbonate (Triphosgene)	$C_3Cl_6O_3$	32315-10-9	NB	NB	ppm	
450	Butyl chloroformate (Butyl chlorocarbonate)	$C_5H_9ClO_2$	592-34-7	NB	NB	ppm	
451	Carbon tetrachloride (Freon 10)	CCl_4	56-23-5	NB	NB	ppm	
452	Chloroacetyl chloride	$C_2H_2Cl_2O$	79-04-9	NB	NB	ppm	
453	Chlorobenzene (Phenyl chloride)	C_6H_5Cl	108-90-7	200	1000	ppm	
454	Chloroform (Trichloromethane; Freon 20)	$CHCl_3$	67-66-3	200	1000	ppm	
455	Chloromethyl chloroformate	$C_2H_2Cl_2O_2$	22128-62-7	NB	NB	ppm	
456	cis-1,2-Dichloroethene	$C_2H_2Cl_2$	156-59-2	200	1000	ppm	
457	Dichloroacetyl chloride	C_2HCl_3O	79-36-7	NB	NB	ppm	
458	Dichloromethane (Methylene chloride; Freon 30)	CH_2Cl_2	75-09-2	200	1000	ppm	
459	Dimethylcarbamyl chloride (Dimethyl carbamic chloride)	C_3H_6ClNO	79-44-7	NB	NB	ppm	
460	Diphosgene	$C_2Cl_4O_2$	503-38-8	NB	NB	ppm	
461	Epichlorohydrin (Chloromethyloxirane)	C_3H_5ClO	106-89-8	NB	NB	ppm	
462	Ethyl chloride	C_2H_5Cl	75-00-3	NB	NB	ppm	
463	Ethyl chloroformate (Carbonochloridic acid ethyl ester; Cathyl chloric	$C_3H_5ClO_2$	541-41-3	NB	NB	ppm	
464	Hexachloro-1,3-butadiene	C_4Cl_6	87-68-3	200	1000	ppm	
465	Methyl chloride (Freon 40)	CH_3Cl	74-87-3	NB	NB	ppm	
466	Methyl chloroacetate	$C_3H_5ClO_2$	96-34-4	NB	NB	ppm	
467	Methyl chloroformate (Methyl chlorocarbonate)	$C_2H_3ClO_2$	79-22-1	NB	NB	ppm	
468	Pentachloroethane	C_2HCl_5	76-01-7	NB	NB	ppm	
469	Pentachlorophenol	C_6HCl_5O	87-86-5	NB	NB	ppm	
470	Phosgene	$COCl_2$	75-44-5	NB	NB	ppm	
471	Propyl chlorocarbonate (n-Propyl chloroformate)	$C_4H_7ClO_2$	109-61-5	NB	NB	ppm	
472	Tetrachloroethylene	C_2Cl_4	127-18-4	200	1000	ppm	
473	trans-1,2-Dichloroethene	$C_2H_2Cl_2$	156-60-5	200	1000	ppm	
474	Trichloroacetyl chloride	C_2Cl_4O	76-02-8	NB	NB	ppm	
475	Trichloroethylene (Trichlorethene)	C_2HCl_3	79-01-6	200	1000	ppm	
476	Vinyl chloride (Chloroethene)	C_2H_3Cl	75-01-4	NB	NB	ppm	
477	Vinylidene chloride (1,1-Dichloroethene)	$C_2H_2Cl_2$	75-35-4	200	1000	ppm	
	Fluoro compounds (see also freons)						
478	(1E)-1,3,3,3-Tetrafluoro-1-propene (HFO-1234ze)	$C_3H_2F_4$	29118-24-9	NB	NB	ppm	
479	1,1,1,2,2,3,5,5,5-Nonafluoropentane	$C_5H_3F_9$	141993-31-9	NB	NB	ppm	
480	1,1,1,2,3,4,4,5,5,5-Decafluoropentane	$C_5H_2F_{10}$	138495-42-8	NB	NB	ppm	
481	2,3,3,3-Tetrafluoropropene (HFO-1234yf)	$C_3H_2F_4$	754-12-1	NB	NB	ppm	
482	2-Fluorotoluene (1-Fluoro-2-methylbenzene)	C_7H_7F	95-52-3	NB	NB	ppm	
483	4-Ethoxy-1,1,1-trifluoro-3-buten-2-one	$C_6H_7F_3O_2$	17129-06-5	NB	NB	ppm	
484	Carbonyl difluoride	COF_2	353-50-4	NB	NB	ppm	12/2019: Availability uncertain. Non-instrument specific references enco
485	Desflurane (1,2,2,2-tetrafluoroethyl difluoromethyl ether)	$C_3H_2F_6O$	57041-67-5	NB	NB	ppm	
486	Ethyl fluoride (Fluoroethane, HFC-161)	C_2H_5F	353-36-6	NB	NB	ppm	
487	Ethyl trifluoroacetate	$C_4H_5F_3O_2$	383-63-1	NB	NB	ppm	
488	Fluorobenzene	C_6H_5F	462-06-6	NB	NB	ppm	
489	Hexafluoropropylene (Perfluoropropene)	C_3F_6	116-15-4	NB	NB	ppm	
490	Methyl fluoride (Fluoromethane, Freon 41)	CH_3F	593-53-3	NB	NB	ppm	
491	Octafluorocyclopentene (Perfluorocyclopentene)	C_5F_8	559-40-0	NB	NB	ppm	
492	Perfluoro-1,2-dimethylcyclohexane	C_8F_{16}	306-98-9	NB	NB	ppm	
493	Perfluoro-1,3-dimethylcyclohexane	C_8F_{16}	335-27-3	NB	NB	ppm	
494	Perfluoro-2-methylpentane	C_6F_{14}	355-04-4	NB	NB	ppm	
495	Perfluoroheptane	C_7F_{16}	335-57-9	NB	NB	ppm	
496	Perfluorohexane	C_6F_{14}	355-42-0	NB	NB	ppm	
497	Sevoflurane [2,2,2-trifluoro-1-(trifluoromethyl) ethyl ether]	$C_4H_3F_7O$	28523-86-6	NB	NB	ppm	
498	Tetrafluoroethylene (Perfluoroethylene)	C_2F_4	116-14-3	NB	NB	ppm	
499	trans-4-(Trifluoromethyl)perfluoro-2-pentene	C_6F_{12}	3709-71-5	NB	NB	ppm	
500	Trifluoroacetic acid	$C_2HF_3O_2$	76-05-1	NB	NB	ppm	
501	Trifluoroethene (Ethylene trifluoride)	C_2HF_3	359-11-5	NB	NB	ppm	
	Freons						
502	Dichlorofluoromethane (Freon 21)	$CHCl_2F$	75-43-4	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
503	Freon 11 (Trichloromonofluoromethane)	CCl_3F	75-69-4	NB	NB	ppm	
504	Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	$C_2Cl_3F_3$	76-13-1	NB	NB	ppm	
505	Freon 113a (1,1,1-Trichloro-2,2,2-trifluoroethane)	$C_2Cl_3F_3$	354-58-5	NB	NB	ppm	
506	Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	$C_2Cl_2F_4$	76-14-2	NB	NB	ppm	
507	Freon 114 B2 (1,2-dibromo-1,1,2,2-tetrafluoroethane)	$C_2Br_2F_4$	124-73-2	NB	NB	ppm	
508	Freon 115 (Chloropentafluoroethane)	C_2ClF_5	76-15-3	NB	NB	ppm	
509	Freon 116 (Hexafluoroethane)	C_2F_6	76-16-4	NB	NB	ppm	
510	Freon 12 (Dichlorodifluoromethane)	CCl_2F_2	75-71-8	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
511	Freon 122 (1,2,2-Trichloro-1,1-difluoroethane)	$C_2HCl_3F_2$	354-21-2	NB	NB	ppm	
512	Freon 123 (1,1-Dichloro 2,2,2-trifluoroethane)	$C_2HCl_2F_3$	306-83-2	NB	NB	ppm	

513	Freon 124 (1-Chloro-1,2,2,2-tetrafluoroethane)	C_2HClF_4	2837-89-0	NB	NB	ppm	
514	Freon 125 (Pentafluoroethane)	C_2HF_5	354-33-6	NB	NB	ppm	
515	Freon 12B1 (Bromochlorodifluoromethane, Halon 1211)	$CBrClF_2$	353-59-3	NB	NB	ppm	
516	Freon 133a (1-Chloro-2,2,2-trifluoroethane)	$C_2H_2ClF_3$	75-88-7	NB	NB	ppm	
517	Freon 134a (1,1,1,2-Tetrafluoroethane)	$C_2H_2F_4$	811-97-2	NB	NB	ppm	
518	Freon 13B1 (Bromotrifluoromethane; Halon 1301)	$CBrF_3$	75-63-8	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
519	Freon 14 (Carbon tetrafluoride)	CF_4	75-73-0	NB	NB	ppm	
520	Freon 141b (1,1-Dichloro-1-fluoroethane)	$C_2H_3Cl_2F$	1717-00-6	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
521	Freon 142b (1-Chloro-1,1-difluoroethane)	$C_2H_3ClF_2$	75-68-3	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
522	Freon 143a (1,1,1-Trifluoroethane)	$C_2H_3F_3$	420-46-2	NB	NB	ppm	
523	Freon 152a (Difluoroethane; Ethylidene Difluoride)	$C_2H_4F_2$	75-37-6	NB	NB	ppm	
524	Freon 218 (Perfluoropropane)	C_3F_8	76-19-7	NB	NB	ppm	
525	Freon 22 (Chlorodifluoromethane)	$CHClF_2$	75-45-6	NB	NB	ppm	
526	Freon 23 (Trifluoromethane)	CHF_3	75-46-7	NB	NB	ppm	
527	Freon 236fa (1,1,1,3,3,3-Hexafluoropropane; HFC-236fa)	$C_3H_2F_6$	690-39-1	NB	NB	ppm	
528	Freon 32 (Difluoromethane)	CH_2F_2	75-10-5	NB	NB	ppm	
529	Freon C318 (Octafluorocyclobutane)	C_4F_8	115-25-3	NB	NB	ppm	
	Other organic compounds						
530	1,1,3,3-Tetramethyldisiloxane	$C_4H_{14}OSi_2$	3277-26-7	NB	NB	ppm	
531	1,3,5-Trioxane	$C_3H_6O_3$	110-88-3	NB	NB	ppm	
532	1-Bromopropane (Propyl bromide)	C_3H_7Br	106-94-5	NB	NB	ppm	
533	2-Bromopropane (Isopropyl bromide)	C_3H_7Br	75-26-3	NB	NB	ppm	
534	Bromoethane (Ethyl bromide)	C_2H_5Br	74-96-4	NB	NB	ppm	
535	Bromoform (Tribromomethane)	$CHBr_3$	75-25-2	NB	NB	ppm	
536	Chloropicrin (Trichloronitromethane, Nitrochloroform)	CCl_3NO_2	76-06-2	NB	NB	ppm	
537	Chlorpyrifos	$C_9H_{11}Cl_3NO_3PS$	2921-88-2	NB	NB	ppm	
538	Cyanogen chloride	CNCl	506-77-4	NB	NB	ppm	Only non-instrument specific references.
539	Decamethylcyclopentasiloxane (D5)	$C_{10}H_{30}O_5Si_5$	541-02-6	NB	NB	ppm	
540	Decamethyltetrasiloxane (L4)	$C_{10}H_{30}O_3Si_4$	141-62-8	NB	NB	ppm	
541	Diazinon	$C_{12}H_{21}N_2O_3PS$	333-41-5	NB	NB	ppm	
542	Dibromomethane (Methylene dibromide)	CH_2Br_2	74-95-3	NB	NB	ppm	
543	Diisopropyl methanephosphonate (DIMP)	$C_7H_{17}O_3P$	1445-75-6	NB	NB	ppm	
544	Dimethoate	$C_5H_{12}NO_3PS_2$	60-51-5	NB	NB	ppm	
545	Dimethyldichlorosilane	$C_2H_6Cl_2Si$	75-78-5	NB	NB	ppm	
546	Dimethyldiethoxysilane	$C_6H_{16}O_2Si$	78-62-6	NB	NB	ppm	
547	Dimethyldimethoxysilane	$C_4H_{12}O_2Si$	1112-39-6	NB	NB	ppm	
548	Dimethylvinylchlorosilane	C_4H_9ClSi	1719-58-0	NB	NB	ppm	
549	Divinyltetramethyldisiloxane	$C_8H_{18}OSi_2$	2627-95-4	NB	NB	ppm	
550	Dodecamethylcyclohexasiloxane (D6)	$C_{12}H_{36}O_6Si_6$	540-97-6	NB	NB	ppm	
551	Dodecamethylpentasiloxane (L5)	$C_{12}H_{36}O_4Si_5$	141-63-9	NB	NB	ppm	
552	Enflurane [2-Chloro-1-(difluoromethoxy)-1,1,2-trifluoroethane]	$C_3H_2ClF_5O$	13838-16-9	NB	NB	ppm	Only non-instrument specific references.
553	Ethylene dibromide (1,2-Dibromoethane)	$C_2H_4Br_2$	106-93-4	NB	NB	ppm	
554	Ethylmethyldichlorosilane	$C_3H_8Cl_2Si$	4525-44-4	NB	NB	ppm	
555	Halothane (Freon 123B1, 2-Bromo-2-chloro-1,1,1-trifluoroethane)	$C_2HBrClF_3$	151-67-7	NB	NB	ppm	
556	Heptamethyltrisiloxane	$C_7H_{22}O_2Si_3$	1873-88-7	NB	NB	ppm	
557	Hexamethylcyclotrisiloxane (D3)	$C_6H_{18}O_3Si_3$	541-05-9	NB	NB	ppm	
558	Hexamethyldisilazane [1,1,1-Trimethyl-N-(trimethylsilyl)-silanamine]	$C_6H_{19}NSi_2$	999-97-3	NB	NB	ppm	
559	Hexamethyldisiloxane (L2)	$C_6H_{18}OSi_2$	107-46-0	NB	NB	ppm	
560	Isoflurane (1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether)	$C_3H_2ClF_5O$	26675-46-7	NB	NB	ppm	
561	Malathion	$C_{10}H_{19}O_6PS_2$	121-75-5	NB	NB	ppm	
562	Methyl bromide (Bromomethane)	CH_3Br	74-83-9	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
563	Methyl iodide	CH_3I	74-88-4	NB	NB	ppm	
564	Methyldichlorosilane	CH_4Cl_2Si	75-54-7	NB	NB	ppm	
565	Methyltrichlorosilane	CH_3Cl_3Si	75-79-6	NB	NB	ppm	
566	Methylvinyldichlorosilane	$C_3H_6Cl_2Si$	124-70-9	NB	NB	ppm	
567	Octamethylcyclotetrasiloxane (D4)	$C_8H_{24}O_4Si_4$	556-67-2	NB	NB	ppm	
568	Octamethyltrisiloxane (L3)	$C_8H_{24}O_2Si_3$	107-51-7	NB	NB	ppm	
569	Pentamethyldisiloxane	$C_5H_{16}OSi_2$	1438-82-0	NB	NB	ppm	
570	Perfluoro-2-n-butyltetrahydrofuran	$C_8F_{16}O$	335-36-4	NB	NB	ppm	
571	Perfluoro-N-methylmorpholine	$C_5F_{11}NO$	382-28-5	NB	NB	ppm	
572	Perfluorotributylamine (Heptacosafluorotributylamine, Fluorinert FC-	$C_{12}F_{27}N$	311-89-7	NB	NB	ppm	
573	Perfluorotripentylamine (Fluorinert FC-70)	$C_{15}F_{33}N$	338-84-1	NB	NB	ppm	
574	Perfluorotripropylamine (Tri(perfluoropropyl)amine)	$C_9F_{21}N$	338-83-0	NB	NB	ppm	
575	Phenylmethyldichlorosilane	$C_7H_8Cl_2Si$	149-74-6	NB	NB	ppm	
576	Phenylphosphonous dichloride (Dichlorophenylphosphine)	$C_6H_5Cl_2P$	644-97-3	NB	NB	ppm	
577	Phenyltrichlorosilane	$C_6H_5Cl_3Si$	98-13-5	NB	NB	ppm	
578	p-Nitrofluorobenzene (4-fluoronitrobenzene)	$C_6H_4FNO_2$	350-46-9	NB	NB	ppm	
579	Propyltrichlorosilane	$C_3H_7Cl_3Si$	141-57-1	NB	NB	ppm	
580	tert-Butyl hydroperoxide	$C_4H_{10}O_2$	75-91-2	NB	NB	ppm	
581	Tertiary Butyl Dimethyl Silyl alcohol (tert-Butyldimethylsilanol)	$C_6H_{16}OSi$	18173-64-3	NB	NB	ppm	
582	Tetraethyl orthosilicate	$C_8H_{20}O_4Si$	78-10-4	NB	NB	ppm	
583	Tetramethyl orthosilicate (Tetramethoxysilane)	$C_4H_{12}O_4Si$	681-84-5	NB	NB	ppm	
584	Tetramethylsilane	$C_4H_{12}Si$	75-76-3	NB	NB	ppm	
585	Thiophosgene	CCl_2S	463-71-8	NB	NB	ppm	
586	Tributyl phosphate	$C_{12}H_{27}O_4P$	126-73-8	NB	NB	ppm	
587	Trichloromethanesulfenyl chloride	CCl_4S	594-42-3	NB	NB	ppm	

588	Triethyl borate	$C_6H_{15}BO_3$	150-46-9	NB	NB	ppm	
589	Triethyl phosphate	$C_6H_{15}O_4P$	78-40-0	NB	NB	ppm	
590	Triethylsilane	$C_6H_{16}Si$	617-86-7	NB	NB	ppm	
591	Trifluoroacetyl chloride	C_2ClF_3O	354-32-5	NB	NB	ppm	
592	Trimethoxysilane	$C_3H_{10}O_3Si$	2487-90-3	NB	NB	ppm	
593	Trimethyl borate (Trimethoxyborane)	$C_3H_9BO_3$	121-43-7	NB	NB	ppm	
594	Trimethylchlorosilane	C_3H_9ClSi	75-77-4	NB	NB	ppm	
595	Trimethylsilanol (Hydroxytrimethylsilane)	$C_3H_{10}OSi$	1066-40-6	NB	NB	ppm	
596	Vinyl bromide (1-Bromoethene, Bromoethylene, R1140 B1)	C_2H_3Br	593-60-2	NB	NB	ppm	
597	Vinyltrichlorosilane	$C_2H_3Cl_3Si$	75-94-5	NB	NB	ppm	
	Inorganic compounds						
598	Ammonia	NH_3	7664-41-7	500	5000	ppm	
599	Arsine	AsH_3	7784-42-1	NB	NB	ppm	
600	Boron trichloride	BCl_3	10294-34-5	NB	NB	ppm	
601	Boron trifluoride	BF_3	7637-07-2	NB	NB	ppm	
602	Carbon(12) dioxide	CO_2	124-38-9	NB	NB	ppm	
603	Carbon(13) dioxide	CO_2	1111-72-4	NB	NB	ppm	
604	Chlorine dioxide	ClO_2	10049-04-4	NB	NB	ppm	Only non-instrument specific qualitative references.
605	Deuterium oxide (Heavy water; Dideuterium oxide)	D_2O	7789-20-0	NB	NB	ppm	
606	Diborane	B_2H_6	19287-45-7	NB	NB	ppm	
607	Dichlorosilane	SiH_2Cl_2	4109-96-0	NB	NB	ppm	
608	Disilane	Si_2H_6	1590-87-0	NB	NB	ppm	
609	Germane	GeH_4	7782-65-2	NB	NB	ppm	
610	Germanium tetrachloride	$GeCl_4$	10038-98-9	NB	NB	ppm	
611	Hydrogen bromide	HBr	10035-10-6	NB	NB	ppm	Only non-instrument specific references.
612	Hydrogen chloride	HCl	7647-01-0	500	5000	ppm	
613	Hydrogen fluoride	HF	7664-39-3	NB	NB	ppm	Only non-instrument specific references.
614	Hydrogen peroxide	H_2O_2	7722-84-1	NB	NB	ppm	Only non-instrument specific references.
615	Nitric acid	HNO_3	7697-37-2	NB	NB	ppm	Only non-instrument specific references.
616	Nitrogen dioxide	NO_2	10102-44-0	500	5000	ppm	Maximum calibration 5%.
617	Nitrogen monoxide (Nitric oxide)	NO	10102-43-9	2000	10000	ppm	
618	Nitrogen trifluoride	NF_3	7783-54-2	NB	NB	ppm	
619	Oxygen difluoride	OF_2	7783-41-7	NB	NB	ppm	Only non-instrument specific references. Chemical not available.
620	Ozone	O_3	10028-15-6	NB	NB	ppm	Only non-instrument specific qualitative references.
621	Phosphine	PH_3	7803-51-2	NB	NB	ppm	
622	Phosphorus oxychloride	$POCl_3$	10025-87-3	NB	NB	ppm	
623	Phosphorus tribromide	PBr_3	7789-60-8	NB	NB	ppm	
624	Phosphorus trichloride	PCl_3	7719-12-2	NB	NB	ppm	
625	Silane (Silicon tetrahydride)	SiH_4	7803-62-5	NB	NB	ppm	
626	Silicon tetrachloride	$SiCl_4$	10026-04-7	NB	NB	ppm	
627	Silicon tetrafluoride	SiF_4	7783-61-1	NB	NB	ppm	
628	Sulfur dioxide	SO_2	7446-09-5	2000	10000	ppm	
629	Sulfur hexafluoride	SF_6	2551-62-4	NB	NB	ppm	
630	Sulfur trioxide	SO_3	7446-11-9	NB	NB	ppm	
631	Sulfuryl chloride (Sulfuryl dichloride)	SO_2Cl_2	7791-25-5	NB	NB	ppm	
632	Sulfuryl fluoride	SO_2F_2	2699-79-8	NB	NB	ppm	Only non-instrument specific references.
633	Thionyl chloride	Cl_2OS	7719-09-7	NB	NB	ppm	
634	Trichlorosilane	$SiHCl_3$	10025-78-2	NB	NB	ppm	
635	Tungsten hexafluoride	WF_6	7783-82-6	NB	NB	ppm	Only non-instrument specific references.
	Chemical warfare agents and derivatives ***						
636	Mustard gas [Bis(2-chloroethyl)sulphide]	$C_4H_8Cl_2S$	505-60-2	NB	NB	ppm	Only non-instrument specific references.
637	Sarin (*o* -Isopropyl methylphosphonofluoridate)	$C_4H_{10}FO_2P$	107-44-8	NB	NB	ppm	Only non-instrument specific references.
638	Soman (*o* -Pinacolyl methylphosphonofluoridate)	$C_7H_{16}FO_2P$	96-64-0	NB	NB	ppm	Only non-instrument specific references.
639	Chlorosoman (1,2,2-Trimethyl propyl methyl phosphonochloridate)	$C_7H_{16}ClO_2P$	7040-57-5	NB	NB	ppm	Only non-instrument specific references.
640	Tabun (*o* -Ethyl N,N-dimethyl phosphoramidocyanidate)	$C_5H_{11}N_2O_2P$	77-81-6	NB	NB	ppm	Only non-instrument specific references.
641	Lewisite (2-Chlorovinyldichloroarsine)	$C_2H_2AsCl_3$	541-25-3	NB	NB	ppm	Only non-instrument specific references.
642	VX (Methylphosphonothioic acid)	$C_{11}H_{26}NO_2PS$	50782-69-9	NB	NB	ppm	Only non-instrument specific references.
643	Diethyl methanephosphonate (DEMP)	$C_5H_{13}O_3P$	683-08-9	NB	NB	ppm	Only non-instrument specific references.
644	Dimethyl methylphosphonate (DMMP)	$C_3H_9O_3P$	756-79-6	NB	NB	ppm	Only non-instrument specific references.
645	Dimethyl phosphite (Dimethyl hydrogen phosphite)	$C_2H_7O_3P$	868-85-9	NB	NB	ppm	Only non-instrument specific references.
646	Diisopropyl methylphosphonate (DIMP)	$C_7H_{17}O_3P$	1445-75-6	NB	NB	ppm	Only non-instrument specific references.

Other components

Not all the components are included in the list above. Please contact Gasmet Technologies Oy for availability and ranges for the components not mentioned.

* GAS-REF-001 price applies only to components with maximum range indicated above.
** GAS-REF-002 price applies only to components with maximum range indicated above.
*** Very limited availability, subject to export limitations.
NB GAS-REF-003 components. Please ask for a price quotation for each component separately.

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