Application Note: 50657

Configuration and Performance of the Antaris IGS Analyzer

Key Words

- Antaris IGS
- Bulk Gas
- Diesel Exhaust
- EPA Protocol Gas
- FT-IR
- Gas Analysis
- Gas Cell

Introduction

Early Thermo Scientific Fourier transform infrared (FT-IR) gas analyzers developed in the mid 1970's performed high-spectral-resolution analysis for understanding processes like smog formation and the chemistry of the upper atmosphere. The 1980's and 1990's saw an increase in computing power and the application of sophisticated spectral analysis on complex mixtures like engine exhaust. Today, Thermo Scientific gas analyzers are used in applications ranging from the purity of breathing oxygen and semiconductor gases, to the detection of low-level pollutants in ambient air, to the characterization of automotive catalysts for protecting the environment. This note describes the variety and types of applications that can be performed with the Antaris™ IGS gas analyzer.

Through a combination of innovative engine design and exhaust after-treatment, this Honda® Insight™ achieves excellent gas mileage with ultra-low emission levels. Antaris IGS gas analyzer can detect even the low emissions from these modern vehicles. Photo courtesy of American Honda Motor Co. Inc.

Examples of Common Applications

NO_x Reduction In Diesel Engine Exhaust

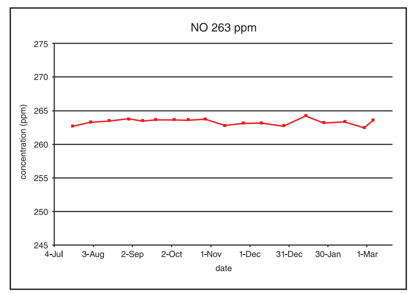
One of the most significant pollution problems facing diesel power trains is the reduction of NO and NO_2 in diesel engine exhaust. Customers have used the accurate concentration output of the Thermo Scientific FTIR gas analyzer for CO, NO, NO_2, N_2O and NH_3 to evaluate and to program the operating parameters of an exhaust after-treatment system.

Bulk Gas

Air separation plants distill air into nitrogen, oxygen and argon. These plants are often located close to the chemical industries that use these products. Unfortunately, some trace-level pollutants can be entrained into the distillation process. Thermo Scientific FT-IR gas analyzers are being used to ensure the purity of these process streams and their trouble-free operation.

EPA Protocol Gas

The calibration of 4- or 5-component gas mixtures is greatly simplified using FT-IR. Studies of discrete analyzers showed problems with cross-interferences, which gave inaccurate measurements of criterion pollutants. The implementation of FT-IR gas analysis has not only provided better analysis accuracy for these mixtures, but significantly improved calibration stability.

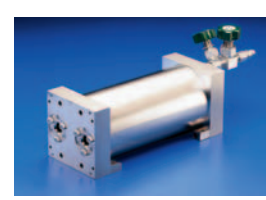


A cylinder of EPA Protocol Gas mixture was analyzed over 7 months without recalibrating the analysis method. The Antaris IGS gas analyzer drift was less than 2 ppm during this period. Data courtesy of Matheson Tri-Gas.

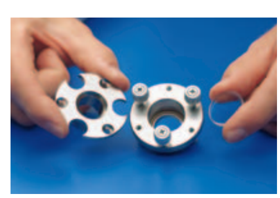
Choosing the Correct Gas Cell

The 10 m gas cell should be selected to get the best sensitivity. However, if the moisture or carbon dioxide concentration in the sample exceeds 3%, the 2 m gas cell will reduce the intensity of these interferences and provide better sensitivity for the analytes. For best temporal resolution with limited sample flow, the lower volumes of the 2 m and 10 cm gas cells have significantly better mixing times than that of the 10 m gas cell. The 10 cm gas cell should be selected when percent-level detection limits are desired.

2 m gas cell



10 m gas cell



10 m cell window holder disassembled

The main components of the 10 m gas cell

Minimum Detection Limits (MDLs) In Air

MDLs were determined on a Antaris IGS analyzer, with a MCT-A detector and a 10 m gas cell, at 0.5 cm^{-1} spectral resolution and a 1 minute analysis time.*§

	MDL (PPBV)		MDL (PPBV)
Acetaldehyde	20	Hydrogen bromide	40
Acetone	10	Hydrogen chloride	15
Acetylene	8	Hydrogen cyanide	10
Acrolein	30	Hydrogen fluoride	10
Acrylonitrile	30	Hydrogen sulfide	10,000
Ammonia	6	Isobutanol	50
Arsine	5	Isobutylene	30
Benzene	20	Isopropanol	50
Boron trichloride	40	Methane	10
Boron trifluoride	40	Methanol	12
Bromomethane	40	Methyl acrylate	20
1,3-Butadiene	15	Methyl amine	50
Butane	40	Methylene chloride	6
n-Butanol	50	Methyl ethyl ketone	45
Carbon dioxide†	10	Methyl isobutyl ketone	45
Carbon monoxide	10	Methyl nitrite	30
Carbon tetrachloride	5	Nitric acid	5
Carbonyl sulfide	5	Nitric oxide	30
CFC-11	2	Nitrogen dioxide	8
CFC-12	3	Nitrogen trifluoride	20
CFC-13	2	Nitrous acid	3
CFC-14	1	Nitrous oxide	5
CFC-22	2	Ozone	70
CFC-113	3	n-Pentane	10
Chlorodifluoromethane	10	Phosgene	5
Chloroethane	30	Phosphine	30
Chloroform	3	Propane	10
Chlorotrifluoromethane	15	Propylene	25
Diborane	5	Styrene	20
1,2-Dibromoethane	10	Sulfur dioxide	10
Dichlorodifluoromethane	5	Sulfur hexafluoride	1
Ethane	15	Silane	20
Ethanol	20	Silicon tetrafluoride	1
Ethyl acetate	4	Toluene	25
Ethyl acrylate	5	Trichloroethylene	7
Ethylene	20	Vinyl bromide	40
Ethylene oxide	7	Vinyl chloride	30
Formaldehyde	15	Water†	20
Formic acid	8	m-Xylene	25
Furan	5	o-Xylene	25
n-Hexane	30	p-Xylene	30

** Detection limits calculated by analyzing the standard error of measurement in a classical least squares concentration analysis where typical levels of moisture and carbon dioxide were accurately compensated. Actual detection limits depend on sampling, equipment, matrix, and environmental parameters, and will be unique to each application.*

§ Detection limits for gases in the gas cell. Some components may require longer flow times for accurate sampling.

† MDL in pure gas, e.g. N_2 or Ar. Analysis at these low levels requires very clean spectrometer purge.

Sensitivity

The following chart lists the maximum peak-to-peak noise levels in absorbance for the specified configurations with a 10 m or 2 m gas cell. The lower noise levels indicate higher sensitivity.

The lower noise levels predict the gas analyzer's ability to detect lower concentrations of trace gases. For the best detection limits, it is important to choose the gas analyzer configuration with the lowest noise level.

0.5 cm^{-1} P-P Noise[1,3]	1 Minute	1 Scan[2]
Antaris IGS gas analyzer with MCT-A detector	0.0006 A	0.0035 A [1 sec]
Antaris IGS gas analyzer with DTGS detector	0.0025 A	0.0075 A [4 sec]

Minimum detection limits for carbon monoxide in a 10 m gas cell are listed below.

CO MDL in a 10 m Cell at 0.5 cm^{-1} [4]	1 Minute	1 Scan[2]
Antaris IGS gas analyzer with MCT-A detector	10 ppbv	60 ppbv [1 sec]
Antaris IGS gas analyzer with DTGS detector	35 ppbv	130 ppbv [4 sec]

Notes

1 Noise levels at lower spectral resolutions will be significantly lower.

2 Collection times will also be significantly lower at lower spectral resolution.

3 For reference, 1 ppm CO in a 10 m cell has peaks at 0.005 Absorbance at 0.5 cm^{-1} spectral resolution at STP.

4 Detection limits were determined using a classical least squares concentration analysis at 0.5 cm^{-1} spectral resolution. For simple mixtures, lower spectral resolution can be used to obtain a better MDL.

Temporal Resolution

The Antaris IGS gas analyzers with RESULT™ software can analyze in real time at 2 Hz at 0.5 cm^{-1} spectral resolution.**

These fast analyses include the graphical display of 5 concentration profiles and storage of infrared and complete concentration data in real-time.

The Antaris IGS gas analyzer with the 10 m cell provides accurate 1 Hz temporal resolution with a sample flow of 10 slpm. With the 2 m cell, 5 slpm is required for 1 Hz temporal resolution.

*** With MCT-A detector.*

Conclusion

The Antaris IGS analyzer can be configured for a wide range of performance requirements and offers excellent performance for a variety of applications. The system provides the sensitivity, speed and spectral resolution to handle the most demanding gas analysis applicants.

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