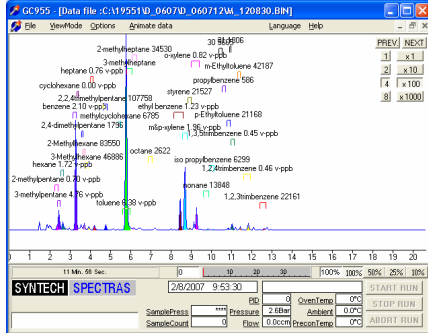
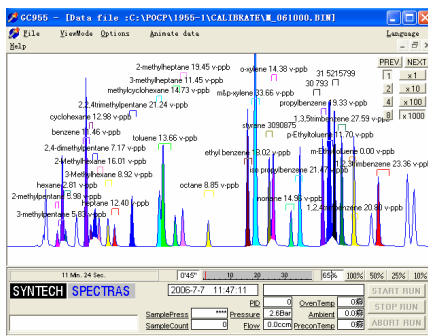


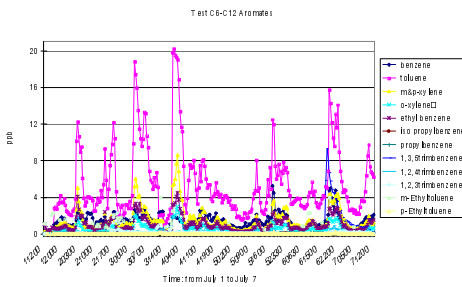
SYNTECH SPECTRAS 611 OZONE PRECURSOR ANALYSER



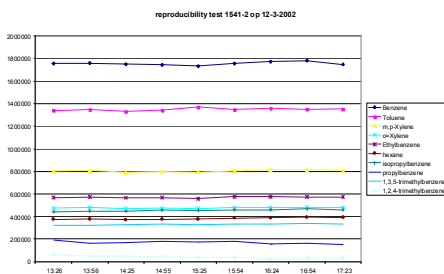
Ambient measurement



Calibration with USA EPA mixture



Results of 7 days ambient measurements



Stability test

HYDROCARBON SELECTION: C6 TO C12

The hydrocarbons monitored in this analyser are selected on two criteria: they are active in ozone formation and the concentration in the air must be above the detection limit for gas chromatography.

In the group measured on the C6 to C12 analyser the source of the hydrocarbons is predominantly the use of fossil fuels. The sources are refineries, evaporation during transport and incomplete burning.

The list contains one carcinogenic compound, benzene.

A few of the compounds are researched as suspect carcinogens. Some compounds can cause long term damage to liver or brains. But the function as ozone precursor is for all compounds except benzene the main reason for monitoring them. In the list all USA EPA C6 to C12 compounds are shown, the compounds also selected by the EU are marked in italics.

USA EPA C6 TO C12 COMPOUNDS

N-Hexane

2-Methylpentane

3-Methylpentane

2,2-Dimethylbutane

2,3-Dimethylbutane

Cyclohexane

Methylcyclopentane

N-Heptane

2-Methylhexane

2,3-Dimethylpentane

2,4-Dimethylpentane

3-Methylhexane

Methylcyclohexane

N-Octane

2-Methylheptane

3-Methylheptane

2,2,4-Trimethylpentane

2,3,4-Trimethylheptane

Benzene

Toluene

Ethylbenzene

M,P-Xylene

O-Xylene

Styrene

Isopropylbenzene

N-Propylbenzene

1,2,4-Trimethylbenzene

1,3,5-Trimethylbenzene

1,2,3-trimethylbenzene

O-Ethyltoluene

M,P-Ethyltoluene

M-Diethylbenzene

P-Diethylbenzene

N-Nonane

N-Decane,

Undecane

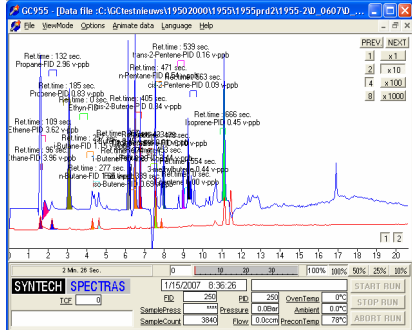
SYNTECH SPECTRAS GC955 611 ANALYSER

Online measurements show concentrations between the detection limit (<0.1 ppb) up to over 20 ppb. Daily concentration variation is often at least a factor 4 for one compound. On many locations the hydrocarbons are not only emitted by traffic, but also by industrial or household processes. The semi continuous analyser of Synspec can follow these changes easily with the 30 minute cycles.

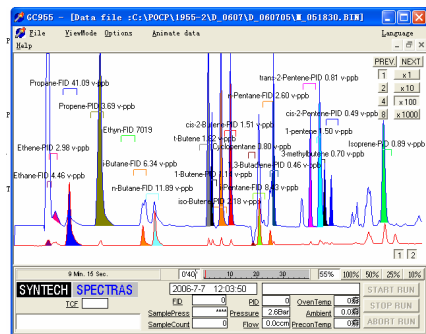
The hydrocarbons are concentrated inside the system to reach a low detection level.

The detector used is a photo ionization lamp: the detector is sensitive to all the hydrocarbons on the list.

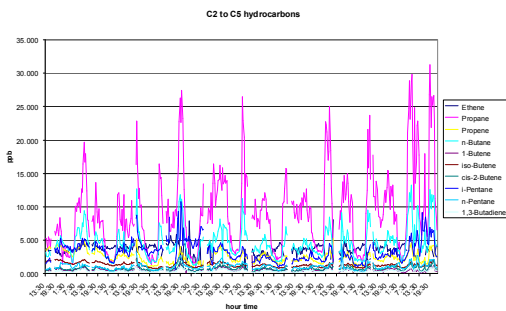
SYNTECH SPECTRAS 811 OZONE PRECURSOR ANALYSER



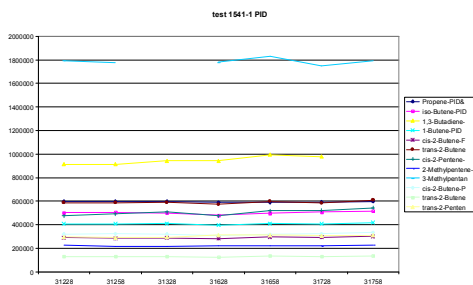
Ambient measurement



Calibration with USA EPA mixture



Results of 7 days of ambient measurements



Stability test of calibration

HYDROCARBON SELECTION: C2 TO C5

The hydrocarbons monitored in this analyser are selected on two criteria: they are active in ozone formation and the concentration in the air must be above the detection limit for gas chromatography.

In the group measured on the C2 to C5 analyser the source of the hydrocarbons is predominantly the petrochemical industry. The source is either refineries, evaporation during transport or incomplete burning. These light hydrocarbons are part of LNG and form the main compounds of LPG. Propane and butane are also widely used as cooking gas.

Ethene and isoprene are also of biogenic origin. The list contains one carcinogenic compound, butadiene. Some compounds can cause short term damage when inhaled and long term damage to liver or brains. But the function as ozone precursor is for all compounds except 1,3-butadiene the main reason to monitor them. In the list all USA EPA C2 to C5 compounds are shown, the compounds also selected by the EU are marked in italics.

USA EPA C2 TO C5 COMPOUNDS

- | | |
|------------------------|----------------------|
| <i>Ethene</i> | <i>Ethane</i> |
| <i>Propene</i> | <i>Propane</i> |
| <i>1-Butene</i> | <i>Iso-Butane</i> |
| <i>Cis-2-Butene</i> | <i>N-Butane</i> |
| <i>Trans-2-Butene</i> | <i>Iso-Pentane</i> |
| Iso-Butane | <i>N-Pentane</i> |
| <i>1-Pentene</i> | Cyclopentane |
| Cis-2-Pentene | <i>1,3-Butadiene</i> |
| <i>Trans-2-Pentene</i> | <i>Isoprene</i> |
| 2-Methyl-1-Pentene | <i>Ethyn</i> |

SYNTECH SPECTRAS GC955 811 ANALYSER

Online measurements show concentrations between the detection limit (<0.1 ppb) up to over 30 ppb. Daily variation is often at least a factor 4 for one compound. On many locations the hydrocarbons are not only emitted by traffic, but also by industrial or household processes. The analyser of Synspec can follow these changes easily with the 30 minutes cycles. The hydrocarbons are concentrated on a cooled trap inside the system to reach a low detection level. Two detectors are used: a photo ionization and a flame ionization: the unsaturated hydrocarbons on the list are detected by the PID, the saturated hydrocarbons are detected by the FID. This makes identification easy. The sensitivity for unsaturated hydrocarbons is very high, these are very reactive in ozone formation.

TECHNICAL DETAILS OF THE OZONE PRECURSOR ANALYSER

The system 611 is a gas chromatograph with a built-in preconcentration system. Hydrocarbons are pre-concentrated on Tenax GR, desorbed thermally and separated on an DB1 equivalent column, to reach optimal separation from interfering hydrocarbons. Analysis is done by a photo ionization detector. This ensures high sensitivity and good identification.

The system 811 is a gas chromatograph with a built-in cooled preconcentration system. Hydrocarbons are pre-concentrated on Carbosieves SIII at 5 °C, desorbed thermally and separated on a combination of two columns, a capillary film column and a capillary PLOT column. In this way the low boiling hydrocarbons can be separated. Analysis is done by a photo ionization detector and a flame ionization detector. This ensures high sensitivity and good identification.

A standard industrial PC with Windows is used. The user-friendly software stores all the chromatograms on the hard disk and data can be interpreted easily with this intuitive software. Data can also be transferred by network and modem connection. Besides this, analogue and digital output options are available to communicate with other data logging systems using several data protocols.

Simple operation, good reliability and low maintenance cost are important to us. With a world wide network of distributors you can be sure that your instrument comes complete with an individualised training and that support is available to help if you do encounter problems.

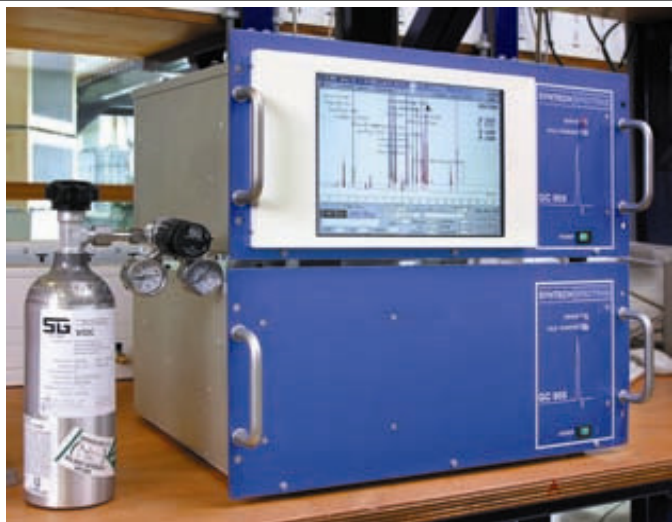
	611 OZONE PRECURSORS FRACTION C6-C10	811 OZONE PRECURSORS FRACTION C2-C5
General	SERIES 600, cycle time 30 min, temp program 20 - 90 °C	SERIES 800, cycle time 30 Min, temp program 50 - 100 °C
Detector	PID detector. Lowest detection level for benzene 0.4 $\mu\text{g}/\text{m}^3$ (0.15 vppb). Range: up to 300 ppb.	PID and FID detector. Lowest detection level for butene 0.4 $\mu\text{g}/\text{m}^3$. Range: up to 300 ppb.
Column	DB1, 30m, 0.32 mm ID, 1.8 μm film	AT5, Al ₂ O ₃ , 5+10m, 0.32 mm ID, 1.8 μm film
Reproducibility	typical <3% at 1 ppb (benzene, with capillary column)	typical <3% at 1 ppb (1,3-butadiene, with capillary column)
Dimensions	19" rack, 5 standard Height Units, depth 39 cm net	19" rack, 5 standard Height Units, depth 39 cm net
Consumption of gas	Nitrogen: quality 5.0, 4 bar, 25 ml/min	Instrument air: dry and clean, 3 bar, 2 x 250 ml/min Nitrogen: quality 5.0, 4 bar, 25 ml/min Hydrogen: quality 5.0, 3 bar, 20 ml/min
Power demand	220 V AC, 200 VA (110 V AC available)	220 V AC, 200 VA (110 V AC available)
Included hardware	Computer Pentium III class, hard disk \geq 40Gb, 2.5", display LCD 10.4 " colour, various data connection options	In an 611/811 combination, shares the computer of the 611. Can be provided with its own computer
Included software	WindowsXPe, PC Anywhere host, Synspec gaschromatography package	WindowsXPe, PC Anywhere host, Synspec gaschromatography package
Options	One PC can control 2 gas chromatographs	
Communication	Control of instrument: direct control via keyboard or mouse, or via remote host (RS232 / modem), ethernet, data exchange protocols available on demand	Control of instrument: direct control via keyboard or mouse, or via remote host (RS232/Ethernet/ modem), data exchange protocols available on demand
Certification	CE approval for EMC conformity: EN 61010-1, EN 61000-6-2 and EN 60111-6-3	CE approval for EMC conformity: EN 61010-1, EN 61000-6-2 and EN 60111-6-3

Extra equipment needed	For the application 811 Permapure dryer, included in the system, needing 250 ml/min dry zero air For the application 611 no extra
Instrument gases	Nitrogen best provided from a bottle, optional from generator. Hydrogen and zero air: from a generator, optional from bottles.
Calibration gases	A multi component mixture, advised Spectra Gases at 1 ppm combined with a dilutor or NPL at 5 ppb without dilutor.

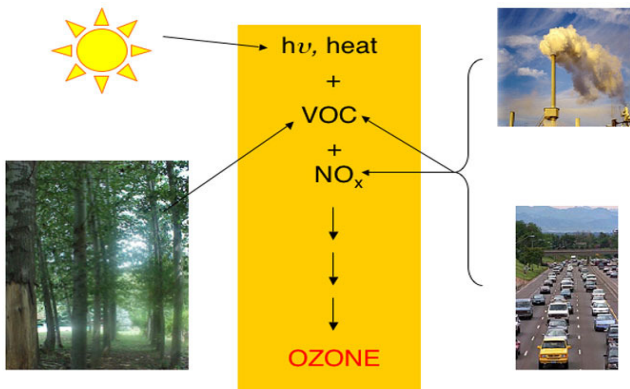
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SYNTECH SPECTRAS OZONE PRECURSOR ANALYSER



Photochemical Production of Ozone



CONTENTS

The Syntech Spectras GC955 series 611/811 VOC analyser is built for the measurement of ozone precursors (POCP) in ambient air.

In this data sheet we give you some background information about ozone precursor hydrocarbons and a description of the Synspec solution for measuring these hydrocarbons. The technical details are found at the back of this leaflet, as well as additional equipment needed.

WHY MEASURE OZONE PRECURSORS?

Ozone is among the most reactive substances in ambient air. In the stratosphere it has a protecting function as it will filter the strongest sun radiation. In the troposphere, the lowest layer of the air, it can be harmful for humans, agriculture and in nature.

Ozone is formed naturally, but also by a reaction of nitrogen oxides and hydrocarbons in certain atmospheric conditions. The reaction is faster under strong sun radiation, high temperature and high humidity.

The products of these reactions are photochemical smog, containing not only ozone, but also very toxic hydrocarbons and fine dust particles. Ozone is a clear indicator of this process.

Depending on the climate the formation will also occur with low concentrations of nitrogen oxides. The hydrocarbon concentration is then the limiting factor in the ozone formation. As different hydrocarbons have a different reactivity in the ozone formation it is useful to measure the individual concentrations.

HYDROCARBONS TO MEASURE

It is important to monitor hydrocarbons that are emitted into the air and to focus on those that have a major effect on the ozone formation. The USA has defined a group of ca. 55 hydrocarbons, responsible for ca. 90 %. The EU meanwhile has defined a list of 28 hydrocarbons, responsible for ca. 80 % of ozone formation.