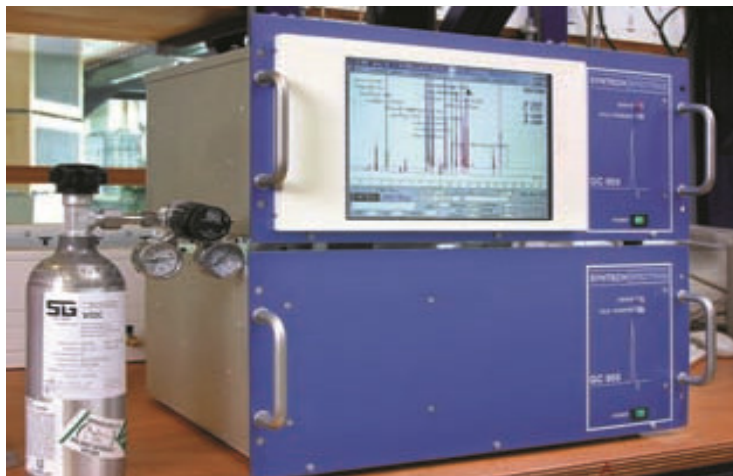


GC955

SYNTECH SPECTRAS OZONE PRECURSOR HYDROCARBON

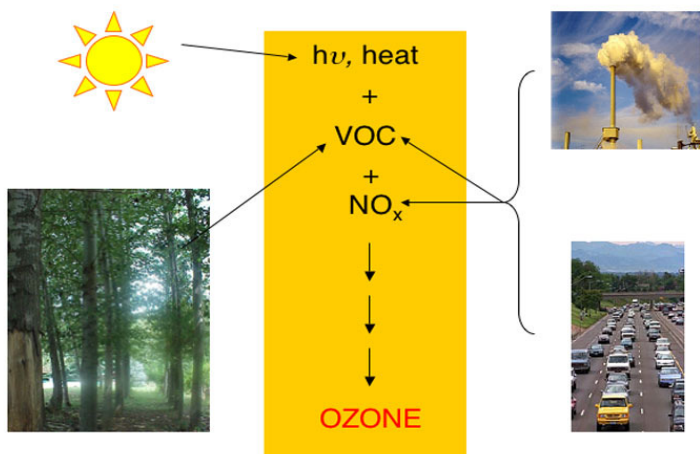


Analyser for the measurement of hydrocarbon ozone precursors in ambient air.

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

Ozone is formed naturally but also by reaction of nitrogen oxides with hydrocarbons in certain atmospheric conditions. The production of ozone proceeds 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.

Photochemical Production of Ozone



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.

At this moment the USA has defined a group of 58 hydrocarbons, the EU has defined a list of 28 hydrocarbons. The first list is responsible for ca. 90 %, the second for ca. 80 % of ozone formation. Knowledge of the main precursors for ozone formation is developing. A revision of the compound lists is made from time to time. In other areas of the world other compounds may be more important. Hydrocarbons emitted by nature must also be included.

In addition, the equipment is capable of measuring hydrocarbons that do not contribute to the formation of ozone, but these are toxic, for instance chlorinated solvents. Including these solvents means that the equipment is used more effectively.

Syntech Spectras GC 955 series 611/811 ozone precursor analyser can measure up to 80 components

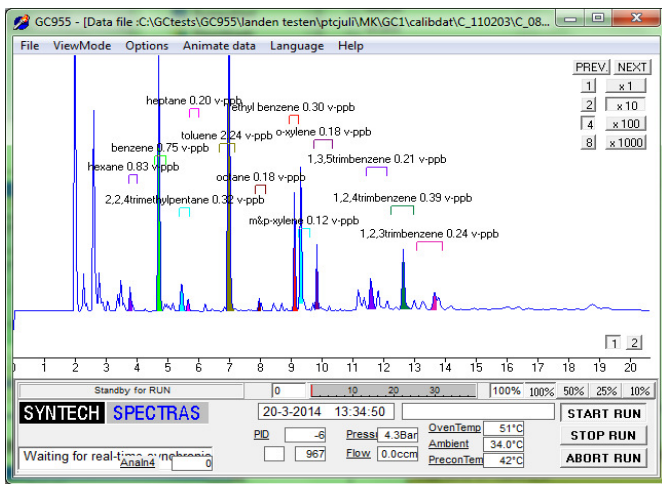
The ozone precursor measurement is done by a combination of two analysers that enables measurement of all components. For hydrocarbons with higher boiling points (BP range > 50 °C) a trap with a low memory effect and a column suitable for separating species present in this BP range is used

For the low boiling hydrocarbon a cooled trap and a column that is dedicated to separate the low boiling hydrocarbons, especially the C4 alkanes and alkenes and the C6 alkane isomers, are used.

Synspec b.v.

SYNTECH SPECTRAS

611 HIGH BOILING FRACTION OZONE PRECURSOR



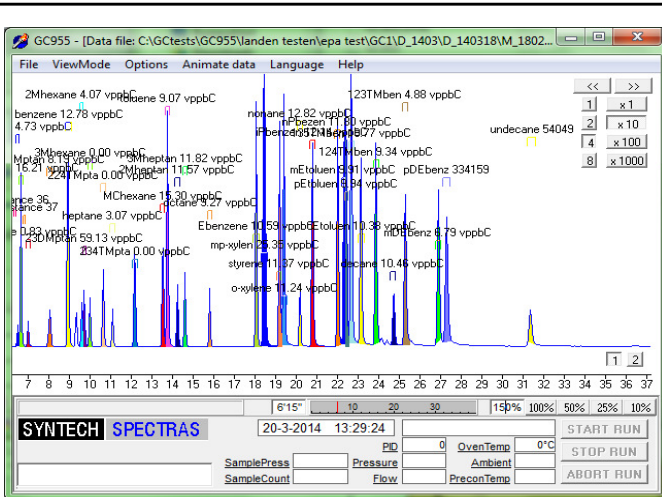
Chromatogram of ambient measurement

Selection of the hydrocarbons C6 to C12

In the group measured on GC 955-611 analyser the source of the hydrocarbons is predominantly fossil fuels. The sources are refineries, evaporation during transport and incomplete burning.

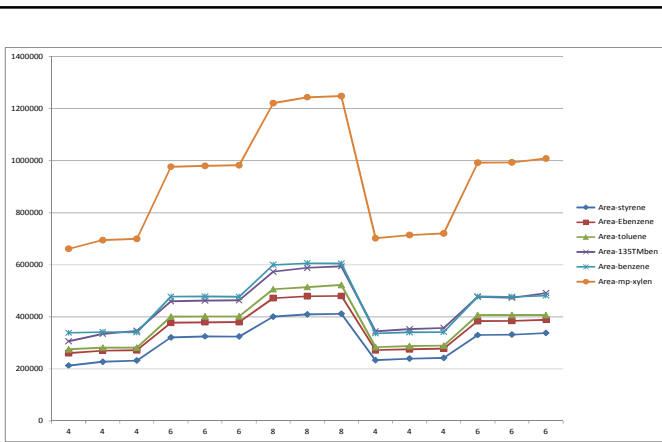
The list contains one carcinogenic compound, benzene. A few of the compounds are being investigated as suspected carcinogens. Some compounds can cause long term damage to liver or brains. But the function as ozone precursor is for all compounds, except benzene, the main reason for monitoring them.

In the list below all USA EPA C6 to C12 compounds are shown. The compounds which are also selected by the EU are marked in **bold**.



Chromatogram of calibration in one hour mode

<i>N</i> -Hexane	<i>N</i> -Octane	<i>N</i> -Propylbenzene
2-Methylpentane	2-Methylheptane	1,2,4-Trimethylbenzene
3-Methylpentane	3-Methylheptane	1,3,5-Trimethylbenzene
2,2-Dimethylbutane	2,2,4-Trimethylpentane	1,2,3-trimethylbenzene
2,3-Dimethylbutane	2,3,4-Trimethylpentane	O-Ethyltoluene
Cyclohexane	Benzene	M-Ethyltoluene
Methylcyclopentane	Toluene	P-Ethyltoluene
N-Heptane	Ethylbenzene	M-Diethylbenzene
2-Methylhexane	M,P-Xylene	P-Diethylbenzene
2,3-Dimethylpentane	O-Xylene	N-Nonane
2,4-Dimethylpentane	Styrene	N-Decane,
3-Methylhexane	Isopropylbenzene	Undecane
Methylcyclohexane		Also α and β pinene



Calibration check of high boiling aromates

Syntech Spectras GC955 611 analyser

Online measurements show concentrations from detection limit (<0.1 ppb) up to over 20 ppb. Daily concentration variation of one compound is often a factor 4. Hydrocarbons are not only emitted by traffic, but also by industrial or household processes.

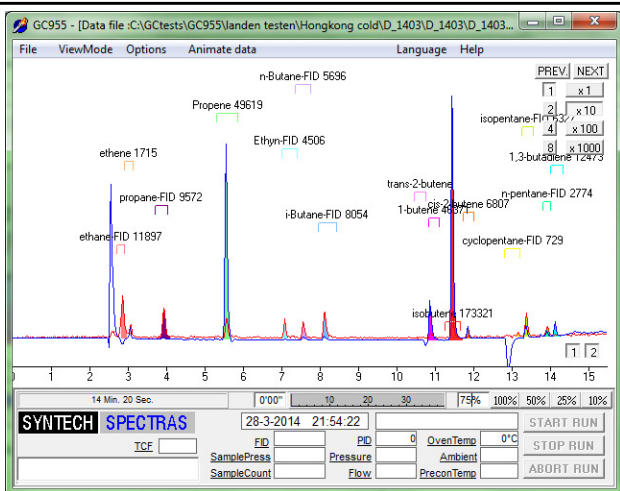
The semi continuous analyser of Synspec can follow these changes easily with the 30 minute cycles. A one hour cycle is also possible. The hydrocarbons are concentrated inside the system to reach a low detection level.

The detector used is a photo ionization lamp: the detector is sensitive to all the hydrocarbons on the list. It is possible to add a FID as second detector.

Boiling point range +50 °C to 250 °C

SYNTECH SPECTRAS

811 LOW BOILING FRACTION OZONE PRECURSOR



Chromatogram of ambient measurement

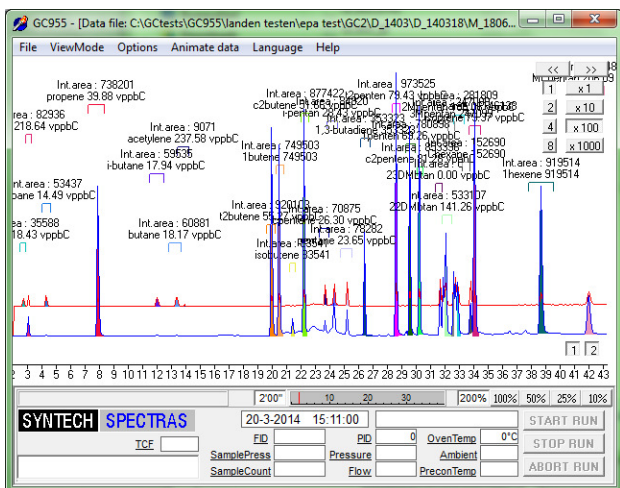
Selection of the hydrocarbons form C2 to C5

The components measured on the GC 955-811 analyser are predominantly emitted by the petrochemical industry. Either from 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 for cooking. 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 below all USA EPA C2 to C5/C6 compounds are shown. The compounds also selected by the EU are marked in **bold**.

Compounds that are underlined are also measured with the 611 system.



Chromatogram of calibration gas in one hour mode

<i>Ethene (ethylene)</i>	<i>Iso-Pentane</i>	2-Methyl-1-Pentene
<i>Ethane</i>	Iso-Butene	Ethyn (acetylene)
<i>Propene (propylene)</i>	<i>N-Pentane</i>	2,3-dimethylbutane
<i>Propane</i>	<i>1-Pentene</i>	<u>2-Methylpentane</u>
<i>1-Butene</i>	Cyclopentane	2,2-dimethylbutane
<i>Iso-Butane</i>	Cis-2-Pentene	<u>3-Methylpentane</u>
<i>Cis-2-Butene</i>	<i>1,3-Butadiene</i>	1-Hexene
<i>N-Butane</i>	Trans-2-pentene	<u>Hexane</u>
<i>Trans-2-Butene</i>	<i>Isoprene (2-methyl-1,3-butadiene)</i>	



Sample conditioning unit with Perma Pure dryer and humidity sensor

Syntech Spectras GC955 811 analyser

Online measurements show concentrations between detection limit (<0.1 ppb) up to over 30 ppb. Daily variation is often at least a factor 4 . The GC955-811 analyser of Synspec can follow these changes easily with the 30 minutes cycles, one hour setting is also possible.

The hydrocarbons are concentrated on a cooled trap inside the system. 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 hydro-carbons is very high.

Sample humidity must be controlled preferably by using the Synspec SCU sample conditioning unit, see separate data sheet.

Boiling point range -80°C to $+50^{\circ}\text{C}$

Technical details of the system

The system 611 is a gas chromatograph with a built-in pre-concentration system. Hydrocarbons are pre-concentrated on Tenax GR, thermally desorbed and separated on an SY1 equivalent column, to reach optimal separation from interfering hydrocarbons. Analysis is done by a photo ionization detector. This ensures high sensitivity and good identification. Optionally an FID can be included.

The system 811 is a gas chromatograph with a built-in cooled pre-concentration system. Hydrocarbons are pre-concentrated on Carbosieves SIII at a temperature below 10°C, (optionally to go down below -10°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. We advise to use the Synspec SCU sample conditioning unit to control the humidity of the sample.

A standard industrial PC with Windows Embedded is used, one PC can control both analysers. The user-friendly software stores all the chromatograms on the hard disk and data can be interpreted easily with the intuitive software. Data can also be transferred by network and modem connection. Besides this, analog 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 individualized training and that support is available to help if you do encounter problems.

Preventive maintenance is only required once a year. For of good quality data it is recommended to have a regular (automatically) calibration or validation. In the software an automatic multipoint validation / calibration is possible using calibration gas of one concentration per component.

The expected lifetime of the analyser is 10 years. Our warranty is 2 years, ask for maintenance requirements. Consumable part cost is low.

Syntech Spectras GC955 series 611 ozone precursor analyser High boiling hydrocarbon fraction

TECHNICAL DESCRIPTION

PID and optionally FID detector. Lowest detection level for benzene $<0.4 \mu\text{g}/\text{m}^3$ (0.15 vppb). Range: up to 300 ppb. Included items: SERIES 600, column SY1 type, 30m, 0.32 mm ID, 1.0 μm film, cycle time 30 or 60 minutes, temp program 50 - 90 °C, flow program Pre-concentration trap at room temperature.

REPEATABILITY

Typical $<3\%$ at 1 ppb (benzene, with capillary column)

GAS CONNECTIONS

Instrument air: dry and clean, 3 bar, 250 ml/min
Nitrogen, quality 5.0, 4 bar, 25 ml/min
Hydrogen, quality 5.0, 3 bar, 20 ml/min

Syntech Spectras GC955 series 811 ozone precursor analyser Low boiling hydrocarbon fraction

TECHNICAL DESCRIPTION

PID and FID detector. Lowest detection level for 1-butene $<0.4 \mu\text{g}/\text{m}^3$. Range: up to 300 ppb. Included items: SERIES 800, column SY5, $\text{Al}_2\text{O}_3\text{-Na}_2\text{SO}_4$, 5+25m, 0.32 mm ID, 10 μm film, cycle time 30 or 60 minutes, temp program 50 - 120 °C, flow program Cooled pre-concentration trap, temp. Range min $<-10^\circ\text{C}$, max $+10^\circ\text{C}$.

REPEATABILITY

Typical $<3\%$ at 1 ppb (butane), with capillary column)

GAS CONNECTIONS

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

GENERAL

CERTIFICATES

CE approval for EMC conformity: EN 61000-6-2, EN 61000-6-3, EN 61010, EN 61326

STANDARD CALIBRATION

Standard calibration provided for ozone precursors, UK NPL primary ozone precursor standard at 4 or 5 ppb as the USA Spectra Gases PAMS standard in the range 5-20 ppb.

DIMENSIONS

19" rack, 5 standard Height Units, depth 43 cm net
(W 48,3 D 43 H 22 CM), WEIGHT 19 and 21 kg

HARDWARE AND SOFTWARE INCLUDED

Industrial PC with Windows Embedded suitable for measuring and saving data up to 10 years. Software for running the analyser as well as for data evaluation and processing on desktops is included.

POWER CONSUPTION

230 V AC, 400 VA (115 V AC available), 50/60 HZ

OPTIONS

Synspec Sample Conditioning Unit (SCU) with internal Perma Pure dryer, humidity sensor and switch between zero, span and sample for both analysers. This item is strongly recommended.

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