Ambient Air Monitoring Applications

airmOzone: 88 VOCs from PAMS and TO14 lists

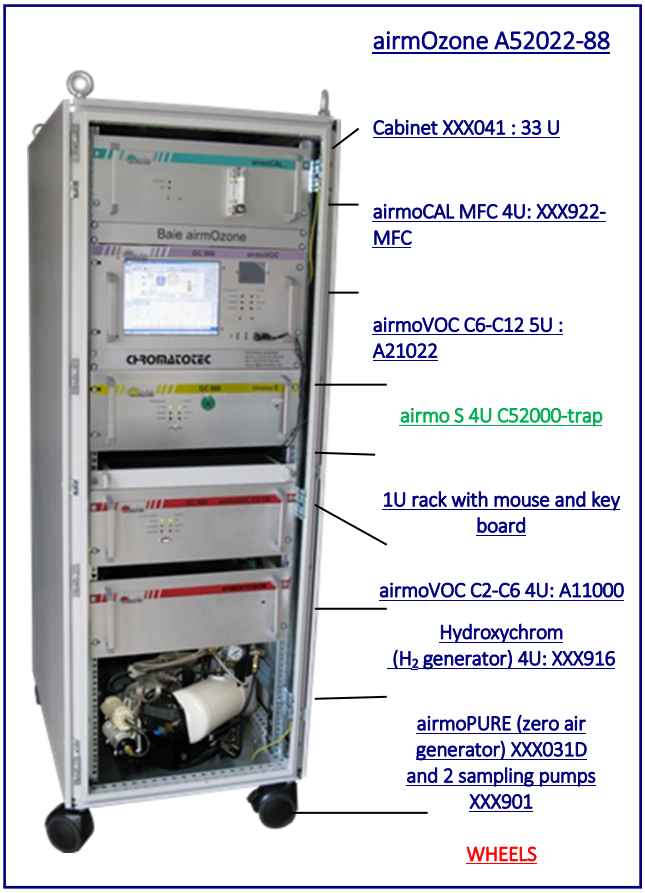
Ozone precursors by FID from WATER or AIR
0 - 325 µg/m^3 or higher

Context & Challenges

Ozone concentration has been multiplied by 5 in the last century in the middle latitudes of the northern hemisphere from 10 PPB in 1874 to approximately 50 PPB today. This is an increase of 1.6% per year; the trend is probably higher (2.4% a year) over the last decades. (Chapter 1 of the International Geosphere-Biosphere Program - World Climate Research Program) In order to stop this global trend, directives have been written concerning the reduction of ozone precursor emissions (NOx and VOC) to define national emission maximum. The Directive 2000/96/EC states that the level of Benzene shall be reduced to an annual average of 5 µg/m3 by 2010 for EU countries (1 ppb = 3.25µg/m3).

Regarding VOC, the European directive 2002/3/CE advises to analyze 31 VOC, continuously and 24 hours per day. US Environmental Protection Agency suggests to analyze 56 VOC which constitute the PAMS program Photochemical Assessment Monitoring Stations. In Japan, 58 VOC are being monitored 56 VOC + Alpha and Beta pinene.

Specific Chromatotec instruments have been designed to meet these new requirements in compliance with EN 14 662-3. Mcerts certification for benzene and VOC on airmovoc C6C12 in 2013. The only autoGC rack mounted system selected by the national US EPA for VOC monitoring.



Chromatotec® Solutions

FID for 88 compounds from air or water

airmOzone: A52022: cabinet 33U
Option airmo S for sulfur
airmOzone: cabinet A52022 made of an airmoVOC C2-C6 and an airmoVOC C6-C12 with FID.

By combining these two instruments, it is possible to analyze light and heavy VOC compounds. Thanks to FID

detection and H2 carrier gas, the separation and sensitivity is excellent down to PPT levels.

The equipment has TUV approval on BTEX, European Mcert certification and US EPA selected on VOCs.
The Instruments are being calibrated with primary gas standard certified at ±2%.
There are no interferences on 10 compounds which can potentially interfere with benzene in compliance with EN 14 662-3 List of the 10 potential interfering compounds with Benzene.
The analyzer is LINEAR: range 0 / 100 ppb (0/325 µg/m3) (see doc airmoBTX / airmoVOC C6-C12, Linearity and repeatability Test).
The instruments are fully automated thanks to internal calibration (airmoCAL MFC). VISTACHROM software controls the analyzers and enables storage and display of the chromatograms thanks to Peak Viewer.
It is possible to transfer data to a data logger with the communication protocols MODBUS RTU, JBUS or German PROTOCOL.
Thanks to those features, the airmOzone is the adequate solution for in situ VOC analysis.

Technical information and results

Application 31 VOC:
30-minutes cycle time
(European directive 2002/3/CE): with 2.Methyl Pentane

1	Ethane
2	Ethene /ethylene
3	Propane
4	Propene / propylene
5	isobutane (2-methyl propane)
6	n-butane
7	Acetylene
8	trans-2-butène
9	1-butene
10	cis-2-butène
11	Iso-pentane (2-methylbutane)
12	n-pentane
13	1-3 butadiene
14	1-Pentene
15	trans-2-pentène
16	cis-2-pentène
17	N-Hexane
18	isoprene
19	1-Hexène
20	Benzene
21	iso-octane
22	n-heptane
23	Toluene
24	n-octane
25	Ethylbenzene
26	m-Xylene
27	p-Xylene
28	o-Xylene
29	1,3,5 trimethylBenzene
30	1,2,4 trimethylBenzene
31	1,2,3 trimethylBenzene

#	Name	Rt Min	Rt Max	Alarm Min	Alarm Max	Factor
1	ETHANE	50,00	60,00	0,00	9999,00	1,00
2	ETHYLENE	72,00	82,00	0,00	9999,00	0,96
3	PROPANE	10,00	110,00	0,00	9999,00	1,00
4	PROPENE	202,00	212,00	0,00	9999,00	0,96
5	I-BUTANE	225,00	235,00	0,00	9999,00	1,00
6	N-BUTANE	242,00	252,00	0,00	9999,00	1,00
7	ACETYLENE	295,00	305,00	0,00	9999,00	0,96
8	TRANS-2-BUTENE	350,00	360,00	0,00	9999,00	0,96
9	1-BUTENE	363,00	373,00	0,00	9999,00	0,96
10	CIS-2-BUTENE	385,00	395,00	0,00	9999,00	0,96
11	I-PENTANE	395,00	405,00	0,00	9999,00	1,00
12	N-PENTANE	412,00	422,00	0,00	9999,00	1,00
13	1-3-BUTADIENE	465,00	475,00	0,00	9999,00	0,93
14	TRANS-2-PENTENE	483,00	493,00	0,00	9999,00	0,93
15	1-PENTENE	500,00	510,00	0,00	9999,00	0,93
16	CIS-2-PENTENE	515,00	525,00	0,00	9999,00	0,93
17	N-HEXANE	558,00	568,00	0,00	9999,00	1,00
18	ISOPRENE	590,00	600,00	0,00	9999,00	1,00
19	1-HEXENE	635,00	645,00	0,00	9999,00	0,97

Compounds analysed by airmoVOC C2C6

#	Name	Rt Min	Rt Max	Alarm Min	Alarm Max	Factor
1	BENZENE	225,00	233,00	0,00	9999,00	1,00
2	CYCLOHEXANE	243,00	251,00	0,00	9999,00	1,00
3	224-TME-PENTANE	317,00	325,00	0,00	9999,00	1,00
4	N-HEPTANE	346,00	354,00	0,00	9999,00	1,14
5	TOLUENE	500,00	510,00	0,00	9999,00	1,05
6	N-OCTANE	613,00	623,00	0,00	9999,00	1,00
7	ETHYLBENZENE	703,00	713,00	0,00	9999,00	1,10
8	M&P-XYLENES	718,00	728,00	0,00	9999,00	1,10
9	STYRENE	745,00	754,00	0,00	9999,00	1,10
10	O-XYLENE	753,00	763,00	0,00	9999,00	1,10
11	N-NONANE	776,00	786,00	0,00	9999,00	1,14
12	135-TMB	852,00	862,00	0,00	9999,00	1,14
13	124-TMB	879,00	889,00	0,00	9999,00	1,14
14	N-DECANE	892,00	902,00	0,00	9999,00	1,13
15	123-TMB	907,00	917,00	0,00	9999,00	1,14

Compounds analysed by airmoVOC C6C12

On the right hand side are the substances tables programmed for the application 31 VOC.

- MIN RT and MAX RT: window identification of compounds in seconds.
- Factor: Response factor for each compound (these factors are set values and the response factor of the relative compound is 1 (BENZENE or N-BUTANE depending on the analyzer). During calibration, a parameter called Base Sensitivity is calculated for the relative compound and then applied to all the other.

OPTION: 2 Methyl Pentane (isohexane) on airmoVOC C2C6 or airmoVOC C6C12

For the application 31 VOC, the standard method lasts 30 minutes. We add 4 other compounds (underlined in red) which are known to be possible interfering species (Cyclohexane and Benzene; Styrene and O-Xylene). We also add Decane and Nonane present in ambient air.

For information, we can identify the origin of several compounds:

- Decane: lubrification oil
- Styrene: petrochemistry
- BTEX: road traffic (four-stroke engine)
- Acetylene: road traffic
- Cyclohexane: solvents, two-cylinder engine such as in mopeds
- 1.3-butadiene:chemical industry & road traffic
- Isoprene: terpene precursor, plant species, biogenous origin
- -Terpenes: (α and β pinenes, limonene…)

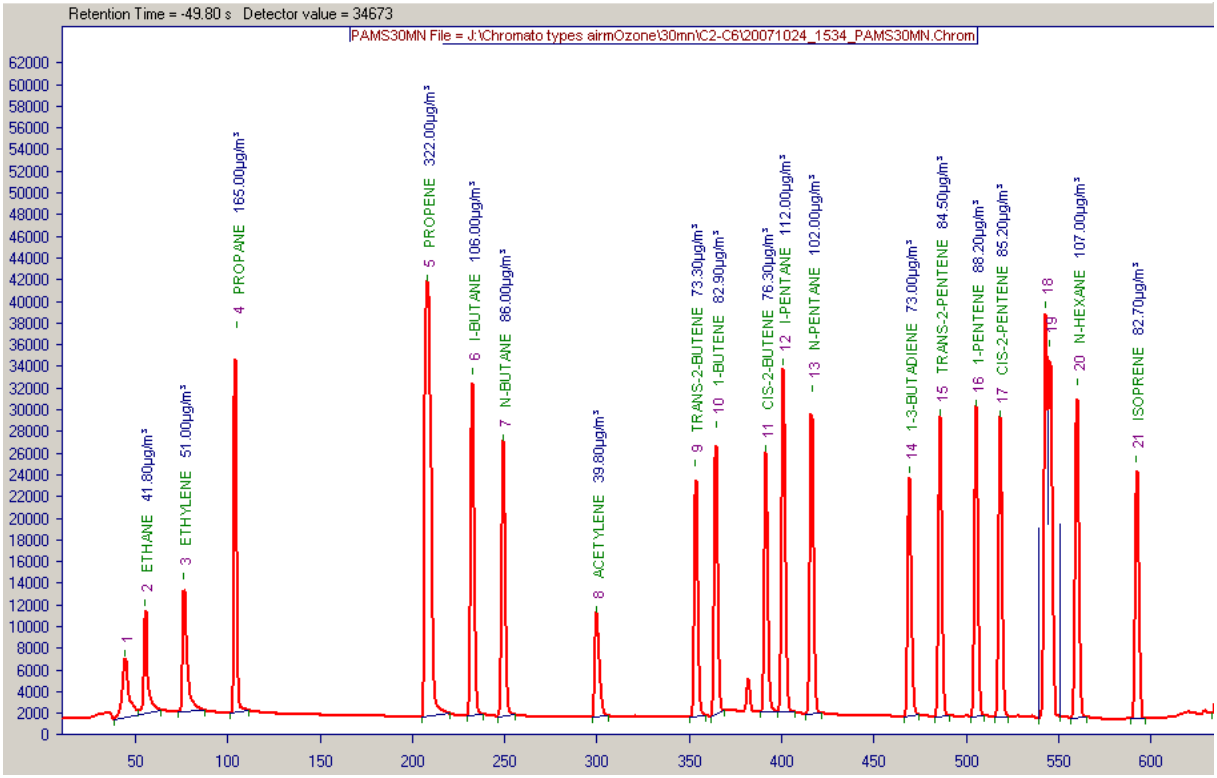


Figure 1. airmoVOC C2-C6 chromatogram in 30-minutes cycle from a 34 VOC gas mixture cylinder with 1-Hexene. European list, 31 compounds: plus 3MePentane and N-Nonane + N-Decane.

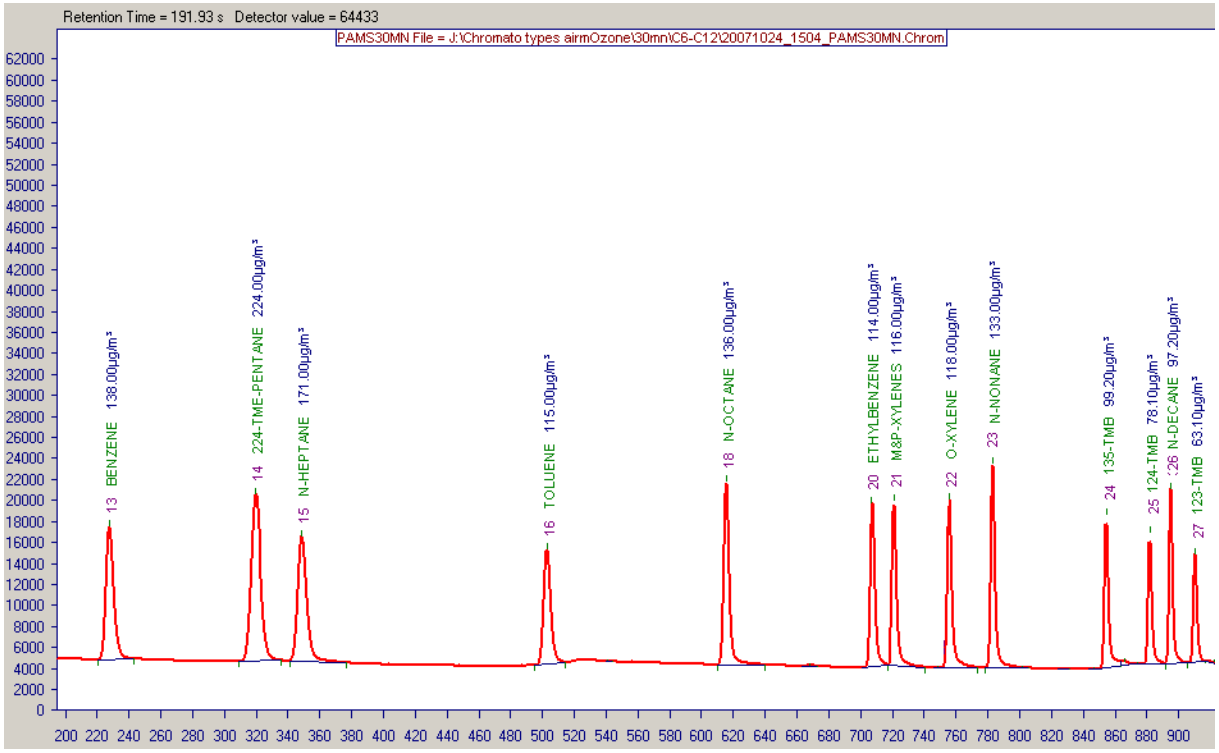


Figure 2. airmoVOC C6-C12 chromatogram in 30-minutes cycle in standard with Mcerts approval for Benzene & VOC

Example from a user: Accredited Association for Air Quality Monitoring in France (AASQA).

- Equipment:

This association has a complete airmOzone and monitors the VOC concentration in ambient air in the vicinity of a large city.

- airmoVOC C2-C6
- airmoVOC C6-C12
- Supervisor
- airmoCAL (multiplexer (zero/calib/ambient) + calibration oven (N-Butane / N-Hexane / Benzene tubes) and cylinder dilution in option
- airmoPURE :zero air generator for VOC
- HYDROXYCHROM: H2 generator with on line drier
- Cabinet for perfect installation

- Data transfer:

Data (substances, concentrations, methods, retention times, alarms…) are transferred from our supervisor to a data logger by MODBUS communication protocol and the data logger transfers data to another location via a phone line.

- Sequence by day with 30-minutes cycle:
- 1 CALIBRATION method (measurement of concentration on standard calibration) : one per day
- 47analytical methods in AMBIENT AIR

- Calibration / Autocalibration: STABILITY

An internal calibration enables follow up and adjust the Base Sensitivity of the instrument which will be used to calculate the concentration of each compound. Calibration standards are permeation tubes calibrated and

certified (±10%), put into the temperature-controlled oven of the airmoCAL. In the range of instruments using FID, auto-calibration is not necessary.

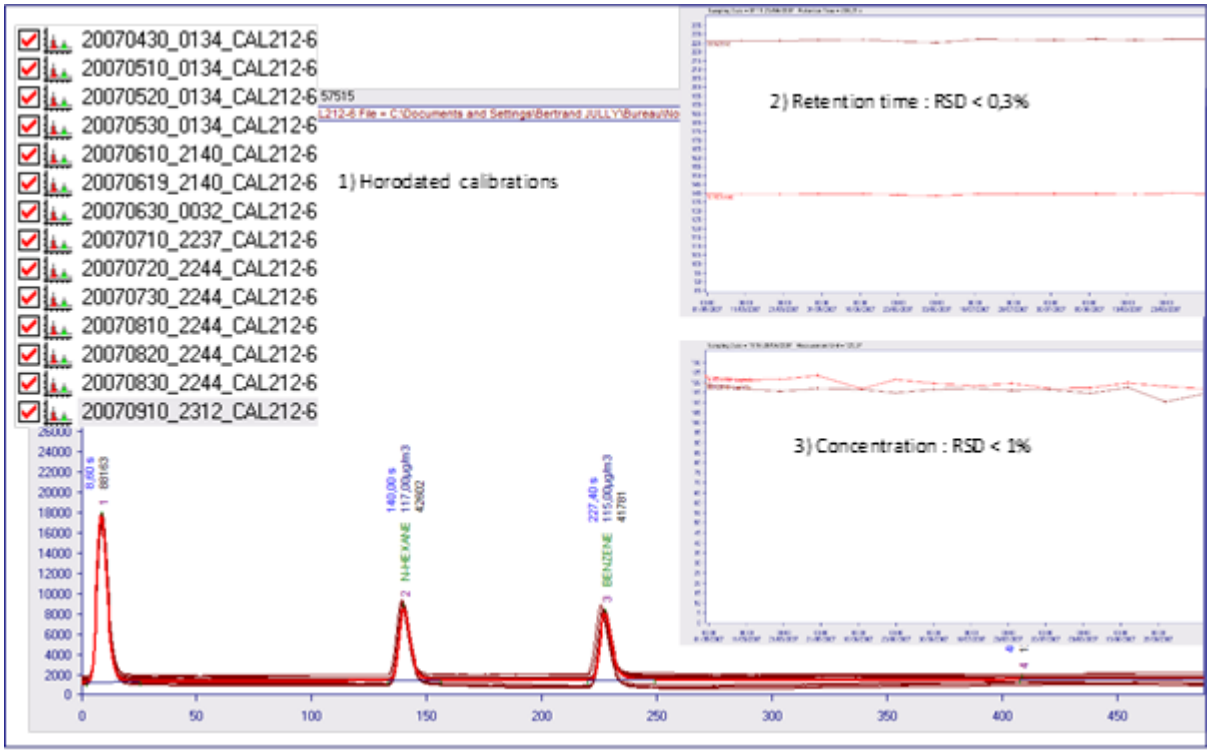


Figure 3. 5-month calibration methods over-lapped (From May to September 2007 on airmOzone C6-C12). We can notice the stability of the retention times and concentrations for Benzene and Hexane.

The fixed station we equipped has been running for more than six months in total autonomy. Next figure shows a week of analytical data in ambient air (April 12 to 18, 2007) viewed with our display software PEAK VIEWER.

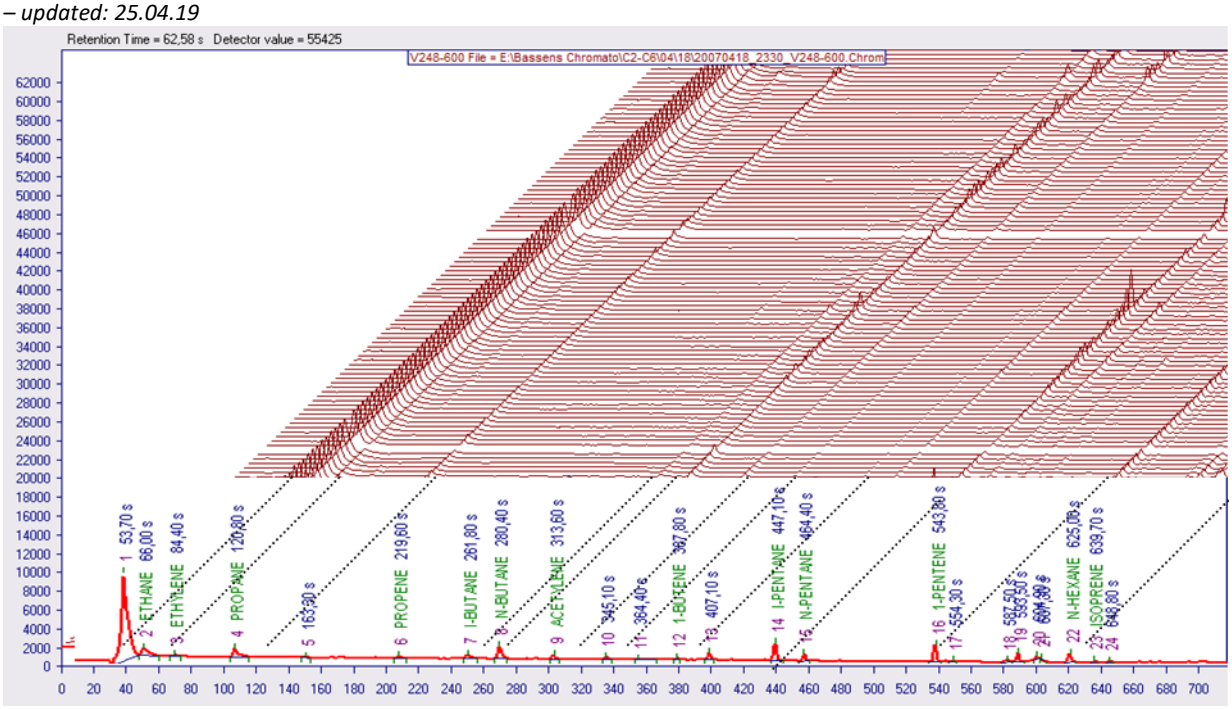


Figure 4. Automatic 3D function PEAK VIEWER software:

By over-lapping follow-ups of concentrations of various compounds over the same period of time, it is possible to identify sources of pollution by their emission profile.

Follow-up of concentrations can be displayed using the Trend function: Trend Result with Peak Viewer software.

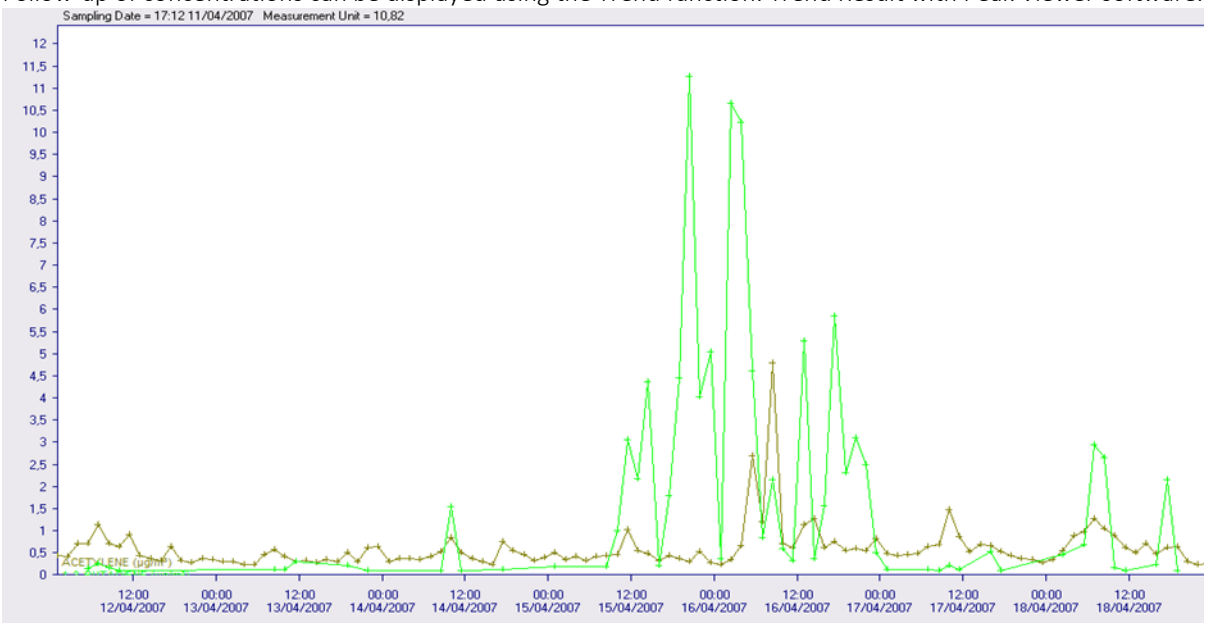


Figure 5. airmoVOC C2-C6 : Follow-up of acetylene concentration (in µg/m3) over one week (April 12 to 18, 2007) : Trend Area function of data processing Peak Viewer software.

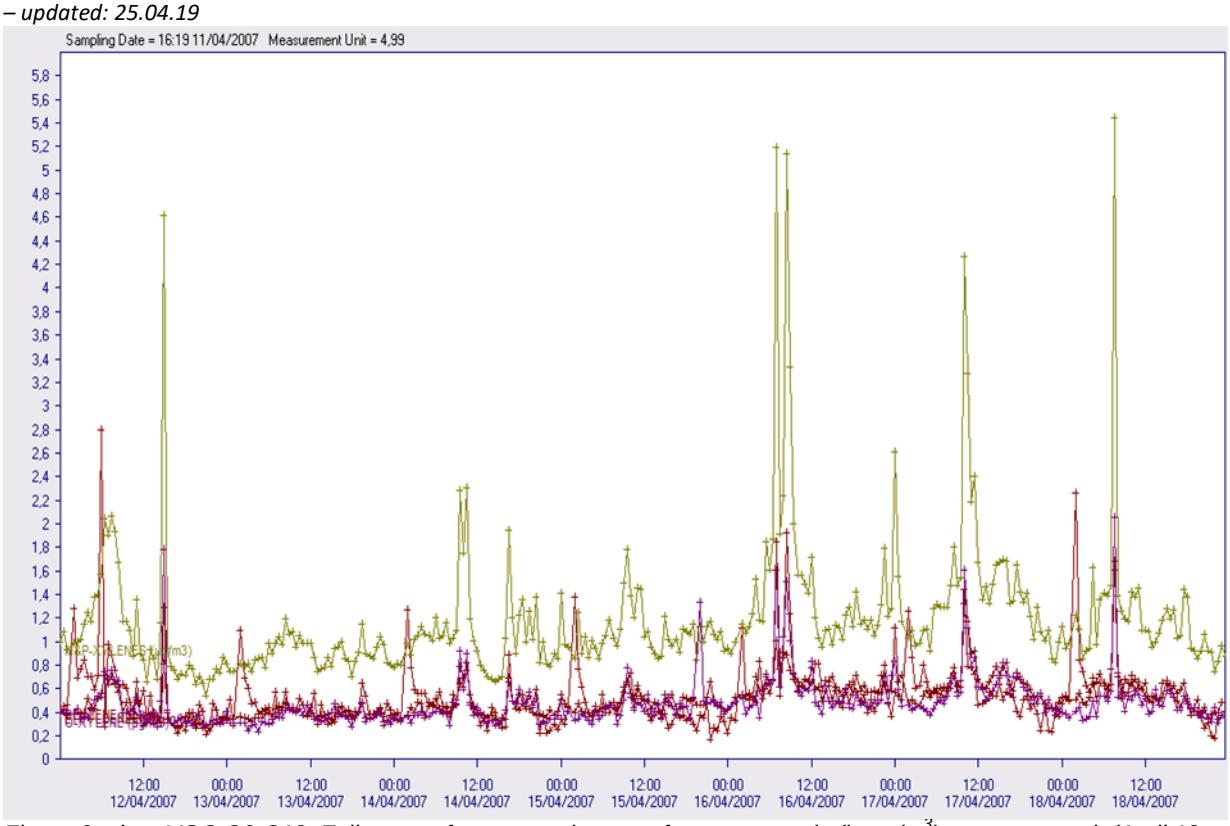


Figure 6. airmoVOC C6-C12: Follow-up of concentration on a few compounds (in µg/m^3) over one week (April 12 to 18, 2007) : Trend Area function of data processing Peak Viewer software.

Acetylene is a tracer of VOC emission by road traffic. We observe that the concentration remains between 0.5 and 1 µg/m3 with maximum concentration in the morning around 9:00 a.m. and in the evening during rush hours. The largest peak occurred at 9:00 a.m. on April 16th when the concentration in the air reached 5µg/m3.

On the airmoVOC C6-C12 unit, during the week of April 12th to 18th, 2007, ethylbenzene, xylenes variations, follow each other perfectly. This is typical of the emission profile observed with road traffic (See Thesis of Caroline Badol, Lille 1, 2005). This observation is confirmed when one compares the variation of the concentration of acetylene and that of BTEX.

It can be noticed that in the vicinity of urban areas, the average benzene concentration is close to 0.5µg/m3 which is lower than the annual average threshold. (The maximum for the European Union was set at 5µg/m3 and must be implemented by 2010).

Pollution peaks occur at road traffic time.

Ranges: 0.1/100ppb or 0/1000ppb or 0/10 000 ppb

Special range for University: 0.01/10ppb or 0.00/1ppb: Mountain or ocean study

Application 56 VOC:

30 minutes cycle

List of PAMS compounds (Program Photochemical Assessment Monitoring Stations: US Environmental Protection Agency):

1	Ethane = C2
2	Ethene / ethylene
3	Propane = C3
4	Propene
5	isobutane (2-méthyl propane)
6	N-butane = C4
7	Acetylene
8	trans-2-butène
9	1-butene
10	cis-2-butène
11	Cyclopentane
12	isopentane (2-methyl butane)
13	N-pentane =C5
14	trans-2-pentene
15	1-pentene
16	cis-2-pentène
17	methylcyplopentane
18	2,3-dimethylbutane
19	2-methylpentane
20	3-methylpentane
21	N-hexane =C6
22	Isoprene
23	2-methyl-1-pentene
24	2,4-dimethylpentane
25	2,2-dimethylbutane
26	Benzene
27	Cychohexane
28	2-methylhexane
29	2,3-dimethylpentane
30	3-methylhexane
31	2,2,4-trimethylpentane
32	N-heptane =C7
33	Methylcyclohexane
34	2,3,4-trimethylpentane
35	Toluene
36	2-methylheptane
37	3-methylheptane
38	N-octane =C8
39	Ethylbenzene
40	m-xylene
41	p-xylene
42	Styrene
43	o-xylene
44	N-nonane =C9
45	Iso propylbenzene
46	N-propylbenzene
47	m-ethyltoluene
48	p-ethyltoluene
49	1,3,5 trimethylbenzene
50	o-ethyltoluene
51	1,2,4 trimethylbenzene
52	N-Decane =C10
53	1,2,3 trimethylbenzene
54	m-diethylbenzene
55	p-diethylbenzene
56	N-Undecane

Compounds analyzed

by airmoVOC C2-C6

#	Name	Rt Min	Rt Max	Alarm Min	Alarm Max	Factor
1	ETHANE	51.00	61.00	0.00	9999.00	1.00
2	ETHYLENE	80.00	90.00	0.00	9999.00	0.96
3	PROPANE	115.00	125.00	0.00	9999.00	1.00
4	PROPENE	268.00	278.00	0.00	9999.00	0.96
5	I-BUTANE	290.00	300.00	0.00	9999.00	1.00
6	N-BUTANE	314.00	324.00	0.00	9999.00	1.00
7	ACETYLENE	405.00	415.00	0.00	9999.00	0.96
8	TRANS-2-BUTENE	465.00	475.00	0.00	9999.00	0.96
9	1-BUTENE	483.00	493.00	0.00	9999.00	0.96
10	CIS-2-BUTENE	515.00	525.00	0.00	9999.00	0.96
11	CYCLOPENTANE	523.00	533.00	0.00	9999.00	1.00
12	I-PENTANE	530.00	540.00	0.00	9999.00	1.00
13	N-PENTANE	550.00	560.00	0.00	9999.00	1.00
14	TRANS-2-PENTENE	653.00	663.00	0.00	9999.00	0.96
15	1-PENTENE	683.00	693.00	0.00	9999.00	0.96
16	CIS-2-PENTENE	700.00	709.00	0.00	9999.00	0.96
17	2-2-DIME-BUTANE	709.00	714.00	0.00	9999.00	1.00
18	ME-CYCLOPENTANE	714.00	718.00	0.00	9999.00	1.00
19	2-3-DIME-BUTANE	728.00	734.00	0.00	9999.00	1.00
20	2-ME-PENTANE	734.00	738.00	0.00	9999.00	1.00
21	3-ME-PENTANE	738.00	748.00	0.00	9999.00	1.00
22	N-HEXANE	755.00	765.00	0.00	9999.00	1.00
23	ISOPRENE	803.00	813.00	0.00	9999.00	1.00
24	2-ME-1-PENTENE	858.00	868.00	0.00	9999.00	1.00

Compounds analyzed by airmoVOC C6-C12

#	Name	Rt Min	Rt Max	Alarm Min	Alarm Max	Factor
1	2-4-DIME-PENTANE	196,00	205,00	0,00	9999,00	1,06
2	BENZENE	238,00	248,00	0,00	9999,00	1,00
3	CYCLOHEXANE	255,00	265,00	0,00	9999,00	1,00
4	2-3-DIMEC5+2MEC6	280,00	285,00	0,00	9999,00	1,10
5	3-ME-HEXANE	297,00	307,00	0,00	9999,00	1,10
6	224-TME-PENTANE	333,00	343,00	0,00	9999,00	1,10
7	N-HEPTANE	363,00	373,00	0,00	9999,00	1,10
8	ME-CYCLOHEXANE	425,00	430,00	0,00	9999,00	1,10
9	234-TME-PENTANE	520,00	530,00	0,00	9999,00	1,10
10	TOLUENE	530,00	540,00	0,00	9999,00	1,05
11	2-ME-HEPTANE	572,00	582,00	0,00	9999,00	1,10
12	3-ME-HEPTANE	593,00	603,00	0,00	9999,00	1,10
13	N-OCTANE	660,00	670,00	0,00	9999,00	1,10
14	ETHYLBENZENE	767,00	775,00	0,00	9999,00	1,10
15	M&P-XYLENES	785,00	793,00	0,00	9999,00	1,10
16	STYRENE	817,00	826,00	0,00	9999,00	1,10
17	O-XYLENE	826,00	836,00	0,00	9999,00	1,10
18	N-NONANE	860,00	870,00	0,00	9999,00	1,10
19	I-PROPYLBENZENE	884,00	894,00	0,00	9999,00	1,09
20	N-PROPYLBENZENE	930,00	940,00	0,00	9999,00	1,08
21	M-ETHYLTOLUENE	940,00	947,00	0,00	9999,00	1,04
22	P-ETHYLTOLUENE	947,00	953,00	0,00	9999,00	1,04
23	135-TMB	955,00	965,00	0,00	9999,00	1,14
24	O-ETHYLTOLUENE	970,00	980,00	0,00	9999,00	1,06
25	124-TMB	990,00	1000,00	0,00	9999,00	1,15
26	N-DECANE	1010,00	1020,00	0,00	9999,00	1,10
27	123-TMB	1030,00	1040,00	0,00	9999,00	1,14
28	M-DIETHYLBENZENE	1060,00	1070,00	0,00	9999,00	1,17
29	P-DIETHYLBENZENE	1070,00	1080,00	0,00	9999,00	1,18
30	N-UNDECANE	1130,00	1140,00	0,00	9999,00	1,20
31	N-DODECANE	1240,00	1250,00	0,00	9999,00	1,20

OPTIONS: 1.3 Butadiene can be analysed by airmoVOC C2C6 (in europeen list / BOLD)

Japan, 58 VOC are concerned (56+ 2 terpenes: Alpha and Beta-pinene).LIMONENE can be analysed also Chinese and KOREAN EPA: We add 1 compound (underlined in red in the above list), N-DODECANE.

Application 88 compounds: PAMS TO 14

Sample: TO14 cylinder diluted in air in order to have around 25 ppb
Sample flow: 11.9 ml/min Sample time: 10 minutes

N°	TO14 cylinder	Formula	BP (°C)	Qty ppb	Analyzer
1	Di chloro di fluoro Methane = 1	Freon 12=CCL2F2	-29.8	103,5	*airmoVOC C_2C_6*
2	chloro Methane = 2	CH3Cl	-24.2	105,8	*airmoVOC C_6C_{12} MS*
3	1,2-dichlorotetrafluoroEthane	Freon 114 =C2CCL2F4	3.8	107,7	*airmoVOC C_2C_6*
4	vinyl chloride = chloro Ethylene = 3	C2H3Cl	-13.9	104,4	*airmoVOC C_2C_6*
5	1,3-butadiene = 5	1,3-C4H6	-4.5	103,9	*airmoVOC C_2C_6*
6	Bromomethane	CH3Br	3.6	104,4	*airmoVOC C_6C_{12} MS*
7	Ethyl chloride = chloro Ethane	C2H5Cl	12.3	103,5	*airmoVOC C_6C_{12} MS*
8	Tri chloro fluoro Methane = 4	Freon 11=CCL3F	24	103,3	*airmoVOC C2C6*
9	Acrylonitrile + Isopentane	C3H3CN	77	102,3	*airmoVOC C_6C_{12} MS*
10	1,1-di chloro Ethylene = 6	1,1-C2H2CL2	31.7	103,9	*airmoVOC C_2C_6*
11	Di chloro Methane = 7	CH2CL2	40	103,1	*airmoVOC*
12	3Chloro-1Propene= Allyl chloride	3-Cl-1-C3H5	45	102,4	*airmoVOC C_6C_{12} MS*
13	Tri chloro tri fluoro Ethane = 8	Freon 113= C2CL3F3	48	103,5	*airmoVOC C_2C_6*
14	1,1-dichloro Ethane	1,1-$C_2H_4Cl_2$	57.2	102,3	airmoVOC C_6C_{12}
15	c-1,2-dichloro Ethylene	c-1,2-$C_2H_2Cl_2$	60	102,3	airmoVOC C_6C_{12}
16	chloroform = Tri Chloro Methane	CHCL3	61	102,3	airmoVOC C_6C_{12}
17	1,2-dichloroethane	1,2-$C_2H_4Cl_2$	83	102,3	airmoVOC C_6C_{12}
18	1,1,1-trichloroethane	1,1,1-$C_2H_3Cl_3$	74	103,2	airmoVOC C_6C_{12}
19	Benzene	C_6H_6	80	102,4	airmoVOC C_6C_{12}
20	carbon tetrachloride	CCl_4	77	102,4	airmoVOC C_6C_{12}
21	1,2-dichloropropane	1,2-$C_3H_6Cl_2$	96	102,4	airmoVOC C_6C_{12}
22	trichloroethylene	C_2HCl_3	87	102,5	airmoVOC C_6C_{12}
23	t-1,3-dichloropropene	t-1,3-$C_3H_4Cl_2$	112	111,6	airmoVOC C_6C_{12}
24	c-1,3-dichloropropene	c-1,3-$C_3H_4Cl_2$	104	93,1	airmoVOC C_6C_{12}
25	1,1,2-trichloroethane	1,1,2-$C_2H_3Cl_3$	74-76	102,3	airmoVOC C_6C_{12}
26	Toluene = methylbenzene	C_7H_8=C_6H_6	110.6	102,4	airmoVOC C_6C_{12}
27	1,2-dibromoethane	1,2-$C_2H_4Br_2$	131-132	102,3	airmoVOC C_6C_{12}
28	tetrachloroethylene	C_2Cl_4	121	102,4	airmoVOC C_6C_{12}
29	chlorobenzene	C_6H_5Cl	132	102,3	airmoVOC C_6C_{12}
30	Ethylbenzene	$(C_2H_5)C_6H_5$	136	102,3	airmoVOC C_6C_{12}
31/32	m+p-xylene =Dimethylbenzene	m-C_8H_{10} + p-C_8H_{10}	138-139	204,8	airmoVOC C_6C_{12}
33	Styrene	$(C_2H_3)C_6H_5$	145-146	102,4	airmoVOC C_6C_{12}
34/35	o-xylene +1,1,2,2tetrachloro Ethane	o-C_8H_{10}	143	205,5	airmoVOC C_6C_{12}
35	1,1,2,2tetrachloro Ethane	1,1,2,2C2H2Cl4	147		*airmoVOC C_6C_{12} MS*
36	4-ethyltoluene (P)	4-$(C_2H_5)C_7H_7$	162	102,7	airmoVOC C_6C_{12}
37	1,3,5-TMB	1,3,5-$(CH_3)_3C_6H_3$	162-164	102,3	airmoVOC C_6C_{12}
38	1,2,4-TMB	1,2,4-TMB+$C_6H_5CH_2Cl$	168	102,3	airmoVOC C_6C_{12}
39/40	1,3-dichlorobenzene + Benzylchloride	1,3-$C_6H_4Cl_2$	173/177-181	204,7	airmoVOC C_6C_{12}
40	Benzylchloride	C7H7Cl	178		*airmoVOC C_6C_{12} MS*
41	1,4-dichlorobenzene	1,4-$C_6H_4Cl_2$	173	102.3	airmoVOC C_6C_{12}
42	1,2-dichlorobenzene	1,2-$C_6H_4Cl_2$	180	102,3	airmoVOC C_6C_{12}
43	1,2,4 -trichlorobenzene	1,2,4-$C_6H_3Cl_3$	214	102,3	airmoVOC C_6C_{12}
44	hexachloro-1,3-butadiene	1,3-C_4Cl_6	210-220	102,4	airmoVOC C_6C_{12}

airmozone PAMS-TO14 can analyse in standard 37 compounds from TO14 cylinder including 10 PAMS in bold black.
Coelutions: M and P Xylene / O-Xylene and 1,1,2,2 tetrachloroethane / 1.3-dichlorobenzene and Benzyl Chloride

airmOzone – MS PAMS TO14 analyse all 44 compounds from the list of TO14 with automatic quantification also for coelutions (O-Xylene & 1,1,2,2 tetrachloroethane) (1,3-dichlorobenzene & Benzyl chloride)
Airtoxic PID VOC 624 analyse 31 compounds (NO detection for *)

- AirmoVOC C2-C6:

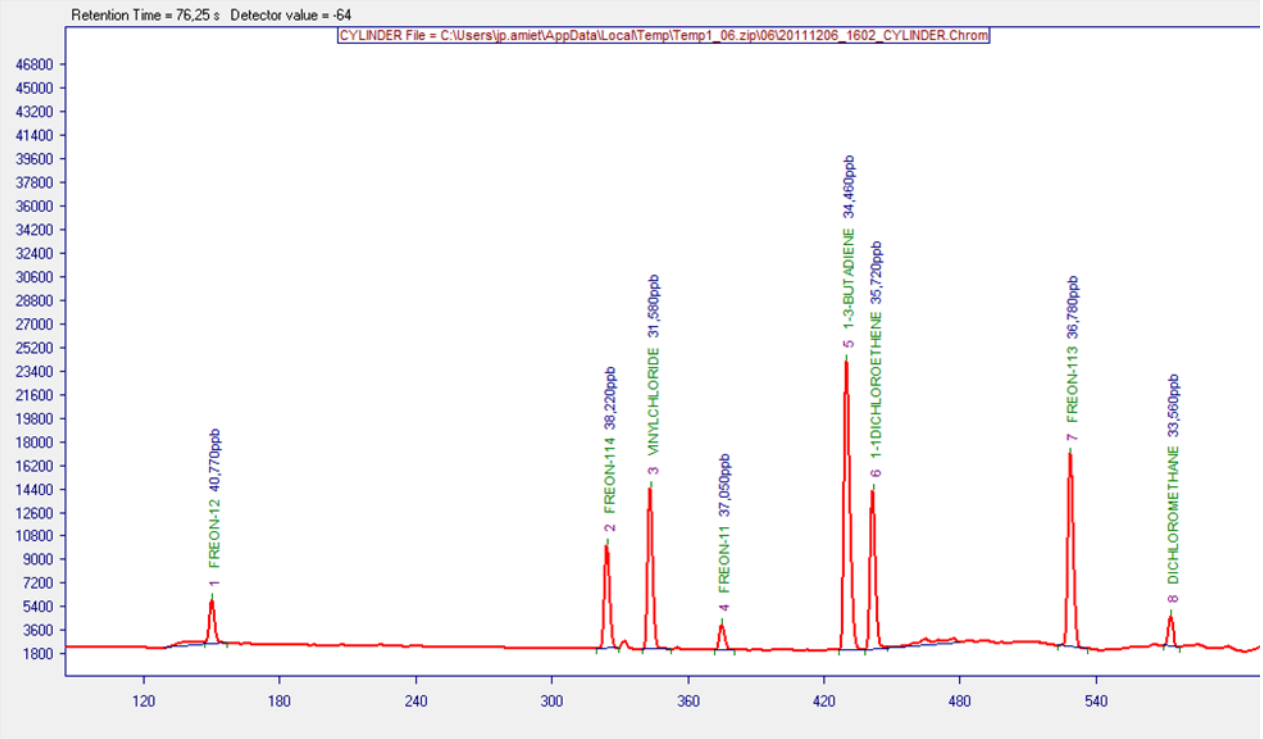


Figure 7. Compounds analyzed from TO14 with airmoVOC C2C6

Program: Cycle time: 1800 seconds: Base Sensitivity = 3800
Sample: TO14 cylinder around 38 ppb
Sample flow: 11 ml/min
sample time: 10 minutes

1) FREON-12 = Di chloro difluoro Methane
2) Freon-114 = 1,2-di chloro tetra fluoro ethane
3) Vinyl chloride = Chloro Ethylene = Chloro Ethene
4) FREON 11 (24) = Tri chloro fluoro Methane
5) 1.3-Butadiene
6) 1.1-Di chloro Ethene
7) FREON 113 = Tri chloro tri fluoro ethane

Di Chloro Methane on airmovocC6C12
Ethyl chloride = Chloro Ethane = NOT IN STANDARD (Analysed with C6C12+MS)
Methyl chloride = Chloro Methane = NOT IN STANDARD (Analysed with C6C12+MS)
Bromo Methane = NOT IN STANDARD (Analysed with C6C12+MS).

Table 1. Substance table from Vistachrom 149

Substances table information

Substances table name: VOC#5550 — Author: CHROMATO-SUD

For the analyzer serial number: #55500517 — Analyzer type: airmoVOC C2-C6

Substances

#	Name	RT Min	RT Max	Select Peak	GC Result formula	W
1	ETHANE	5	15	Max	1,1 * X	Ar
2	ETHYLENE	25	35	Max	1,1 * X	Ar
3	PROPANE	64	74	Max	1,05 * X	Ar
4	FREON-12	142	152	Middle	16 * X	Ar
5	PROPENE	154	164	Max	1,1 * X	Ar
6	I-BUTANE	196	206	Max	X	Ar
7	N-BUTANE	211	221	Max	X	Ar
8	ACETYLENE	237	253	Max	1,15 * X	Ar
9	TRANS-2-BUTENE	297	305	Middle	0,98 * X	Ar
10	1-BUTENE	309	317	Max	0,98 * X	Ar
11	FREON-114	319	328	Middle	10 * X	Ar
12	VINYLCHLORIDE	340	347	Middle	2,05 * X	Ar
13	I-BUTENE	346	354	Max	0,98 * X	Ar
14	CIS-2-BUTENE	353	363	Max	0,98 * X	Ar
15	CYCLOPENTANE	369	375	Middle	X	Ar
16	FREON-11	373,5	377,5	Middle	31 * X	Ar
17	I-PENTANE	379	387	Middle	X	Ar
18	N-PENTANE	391	401	Max	X	Ar
19	1-3-BUTADIENE	426	434	Max	0,93 * X	Ar
20	1-1DICHLOROETHENE	441	447	Middle	3,5 * X	Ar
21	TRANS-2-PENTENE	458	466	Max	0,98 * X	Ar
22	1-PENTENE	476	484	Middle	0,98 * X	Ar
23	CIS-2-PENTENE	485	493	Max	0,98 * X	Ar
24	ME-CYCLOPENTANE	519	524	Middle	X	Ar
25	FREON-113	527	531	Middle	5,5 * X	Ar
26	2-3-DIME-BUTANE	531	531	Middle	X	Ar
27	2-ME-PENTANE	532	536	Middle	X	Ar
28	3-ME-PENTANE	536	540	Middle	X	Ar
29	N-HEXANE	545	555	Middle	X	Ar
30	ISOPRENE	552	560	Middle	2,2 * X	Ar
31	DICHLOROMETHANE	571	576	Middle	15 * X	Ar
32	2-ME-1-PENTENE	584	592	Middle	0,98 * X	Ar
32	2-ME-1-PENTENE	584	592	Middle	0,98 * X	Ar
33	4-ME-1-PENTENE	593	598	Middle	X	Ar
34	1-HEXENE	616	624	Middle	0,98 * X	Ar
35	2-4-DIME-PENTANE	655	663	Middle	X	Ar

Curve response of detector: Linear

Factor * X

With X = (Area + AreaOfs) / BS

Name	Value
Factor	1,1
AreaOfs	0

Cyclohexane and Me-Cyclopentane analysed also on C6C12
IsoBUTENE = (I-BUTENE) not in PAMS

- airmoVOC C6-C12 : Blue peak not identified by PID

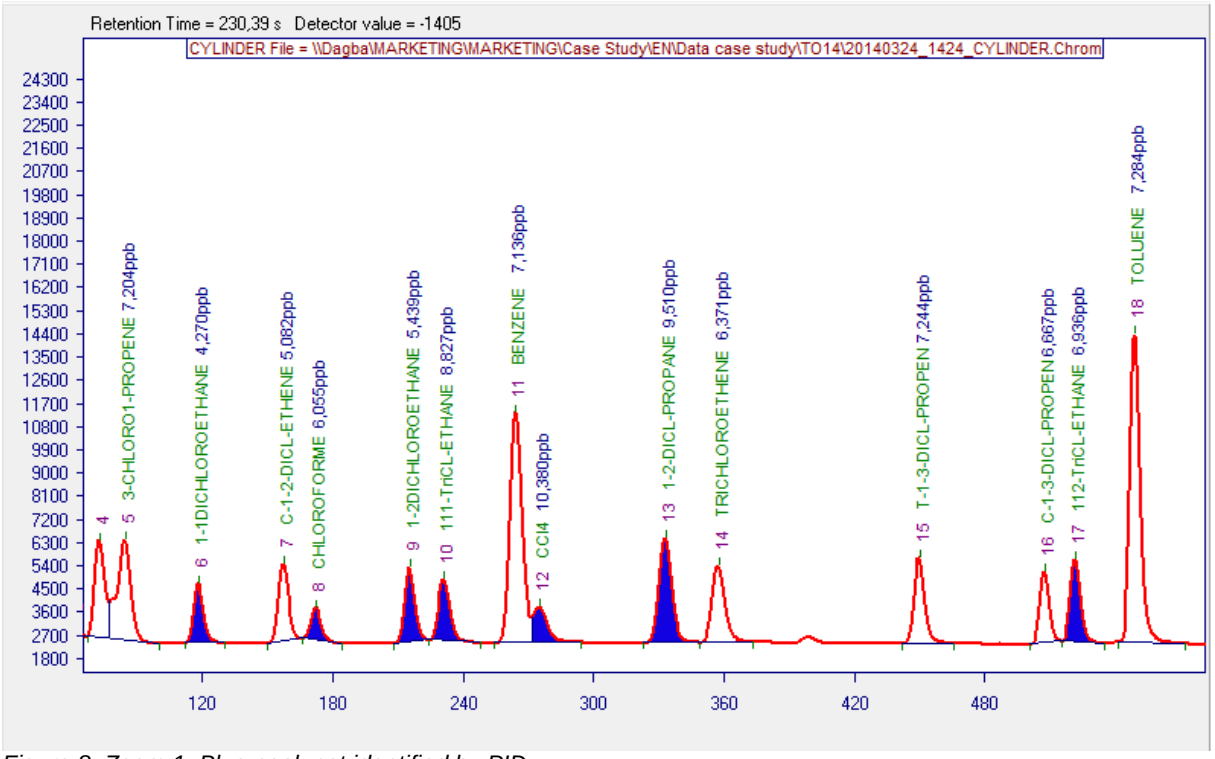


Figure 8. Zoom 1. Blue peak not identified by PID

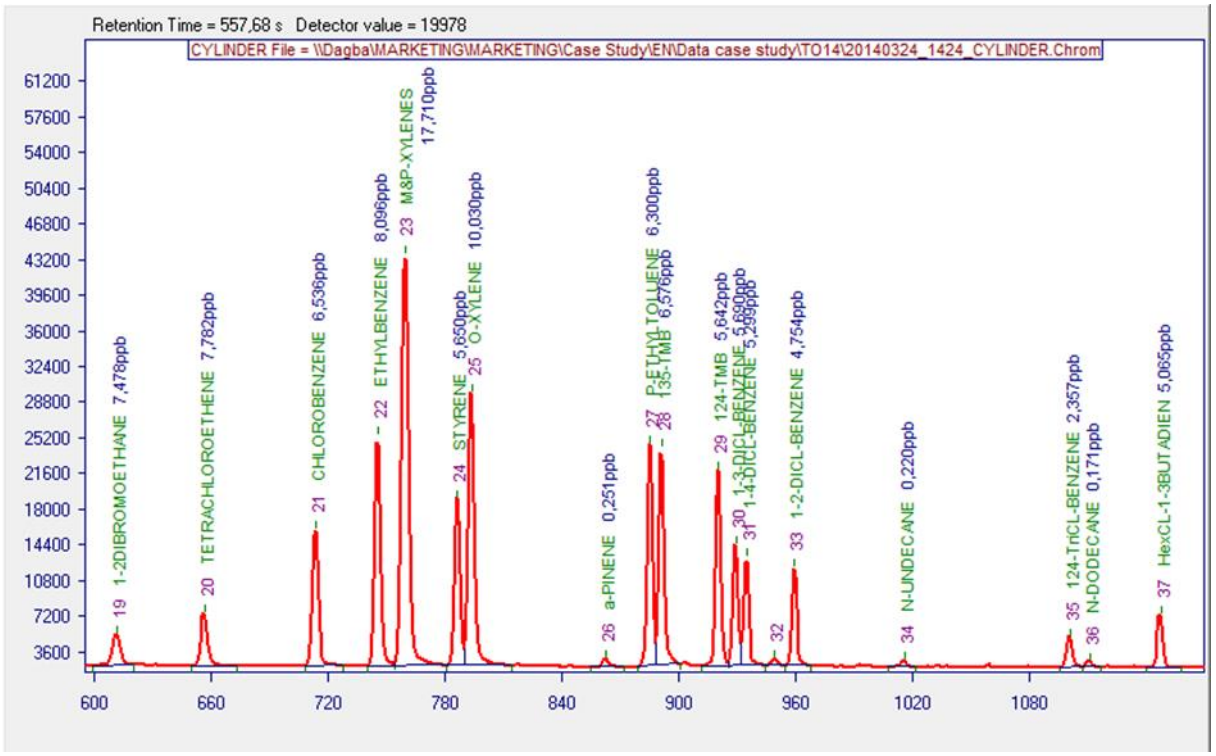


Figure 9. Zoom 2.

Program: Cycle time: 1800 seconds: Sensitivity = 4890: TO14 from sample bag (only qualitative) MeCycloPentane/ already analysed on C2C6

Coelution of: 2.3dimeC5 and 2meC6 / M-Xylene and P-Xylene / Benzylchloride and 1.2.4 TMB
Before 3-Chloro 1 Propene on C6C12 there is Acrylonitrile an1-1 Dichloroethene, they can be analysed with MS

Table 2. Substance table from Vistachrom 1.49

#	Name	RT Min	RT Max	Select Peak	GC Result formula	W
1	3-CHLORO1-PROPENE	81	89	Middle	2 * X	Ar
2	2-2-DIME-BUTANE	88	96	Middle	1,1 * X	Ar
3	1-1DICHLOROETHANE	114	122	Middle	3,32 * X	Ar
4	C-1-2-DICL-ETHENE	152	160	Middle	3 * X	Ar
5	CHLOROFORME	168,5	174,5	Middle	10 * X	Ar
6	1-2DICHLOROETHANE	211	217	Middle	3,32 * X	Ar
7	111-TriCL-ETHANE	226	234	Middle	8 * X	Ar
8	BENZENE	258	268	Middle	X	Ar
9	CCl4	268	278	Middle	16 * X	Ar
10	CYCLOHEXANE	278	288	Max	1,1 * X	Ar
11	2-3-DIMEC5+2MEC6	295	303	Middle	1,1 * X	Ar
12	3-ME-HEXANE	316	324	Max	1,15 * X	Ar
13	1-2-DICL-PROPANE	329	337	Middle	4 * X	Ar
14	TRICHLOROETHENE	355	361	Max	4,31 * X	Ar
15	224-TME-PENTANE	359	367	Max	1,1 * X	Ar
16	N-HEPTANE	386	396	Middle	1,12 * X	Ar
17	T-1-3-DICL-PROPEN	444	452	Middle	4,19 * X	Ar
18	ME-CYCLOHEXANE	451	459	Middle	1,1 * X	Ar
19	C-1-3-DICL-PROPEN	502	510	Middle	5,54 * X	Ar
20	112-TriCL-ETHANE	516	524	Middle	5,41 * X	Ar
21	234-TME-PENTANE	530	540	Middle	1,1 * X	Ar
22	TOLUENE	542	552	Middle	1,05 * X	Ar
23	2-ME-HEPTANE	580	590	Middle	1,1 * X	Ar
24	3-ME-HEPTANE	605	615	Middle	1,1 * X	Ar
25	1-2DIBROMOETHANE	618	628	Middle	9,15 * X	Ar
26	N-OCTANE	649	657	Max	1,12 * X	Ar
27	TETRACHLOROETHENE	654,5	660,5	Middle	5,6 * X	Ar
28	CHLOROBENZENE	704	714	Middle	1,47 * X	Ar
29	ETHYLBENZENE	736	746	Middle	1,1 * X	Ar
30	M&P-XYLENES	750	760	Middle	1,1 * X	Ar
31	STYRENE	782	790	Middle	1,1 * X	Ar
32	O-XYLENE	789	797	Middle	1,1 * X	Ar
33	N-NONANE	811	821	Middle	1,14 * X	Ar
34	I-PROPYLBENZENE	831	841	Middle	1,15 * X	Ar
35	a-PINENE	858	866	Middle	X	Ar
36	N-PROPYLBENZENE	868	876	Middle	1,1 * X	Ar
37	M-ETHYLTOLUENE	877	883	Middle	1,15 * X	Ar
38	P-ETHYLTOLUENE	881	887	Middle	1,15 * X	Ar
39	135-TMB	886	894	Middle	1,15 * X	Ar
40	O-ETHYLTOLUENE	898	904	Middle	1,1 * X	Ar
41	b-PINENE	905	913	Middle	X	Ar
42	124-TMB	916	924	Middle	1,15 * X	Ar
43	1-3-DICL-BENZENE	925	933	Max	2,3 * X	Ar
44	N-DECANE	930	934	Max	1,2 * X	Ar
45	1-4-DICL-BENZENE	934,5	940,5	Middle	2,3 * X	Ar
46	123-TMB	945	953	Middle	1,15 * X	Ar
47	1-2-DICL-BENZENE	954	962	Middle	2,3 * X	Ar
48	M-DIETHYLBENZENE	968	975	Middle	1,22 * X	Ar
49	P-DIETHYLBENZENE	975	983	Middle	1,24 * X	Ar
50	N-UNDECANE	1015	1025	Middle	1,3 * X	Ar
51	124-TriCL-BENZENE	1082	1092	Middle	4,1 * X	Ar
52	N-DODECANE	1099	1107	Middle	1,3 * X	Ar
53	HexCL-1-3BUTADIEN	1140	1150	Middle	6,9 * X	Ar

Curve response of detector

Linear

Factor * X

With X = (Area + AreaOfs) / BS

Name	Value
Factor	6,9
AreaOfs	0

Conclusion:

airmOzone A52022 several benefits:

- fully automated with gas generator (H2/AIR/CALIBRATION gas)
- data transfer to a data logger or by modem or ethernet
- stability and repeatability (from 0,01 to 100 ppb, areas and retention times)
- Linearity (from 0.01 to 100ppb) (see doc airmoBTX / airmoVOC C6-C12, Linearity and repeatability Test with Mcerts in 2013).
- in compliance with EN 14 662-3, no interferences (see doc: List of the 10 potential interfering compounds with Benzene) …
- International certification on BTEX and other VOCs (TUV in 1996, Mcerts in 2013
- The only rack mounted autoGC selected by national US EPA in 2014 for VOC monitoring
- List of 88 compounds from TO14 and PAMS: airmOzone A52022- TO14/PAMS: 35 on airmoVOC C2C6 and 53 on C6C12

The two instruments can analyze cyclo Hexane, 22Di Methyl Butane, Methyl Cyclopentane, 2 and 3 Methyl Pentane.
Thanks to those features, the airmOzone is the adequate solution for on-site VOC analysis for surveillance of industrial area: VOC from (water or air or ground).

OPTION:
- For expertise, quantification of compounds with bad separation and more compounds analyzed: all PAMS, TO14 and some TO15 compounds
  - o NEW: airmOzone + Process Quadrupole Mass Spectrometer for 88 or up to 123 compounds (TO14 and TO15 compounds react with FID and MS)
- For sulphur compounds:
  - o TRS MEDOR® range 1 to 100 ppb H2S/MM/SO2/EM/DMS/DES/DMDS
  - o NEW airmoS range 0.1 to 100 ppb for MM/EM/DMS/DES/DMDS and CS2

Remarks:

1- On airmoVOC C6C12, before 1,2-dichloro Ethane, we can find interference (like Hexane/chloroform …)

2- On airmoVOC C6C12: chloromethane, chloroethane, Bromo Methane, acrylonitrile are analyzed with airmOzone + MS

3- TO14 Method 44 compounds react with FID: best sensitivity is with benzene; the worst SENSITIVITY is with CCL4 and FREON 11 AND 113. MS react better than FID with FREON(s).

4- M&P XYLENE are co eluted with standard column; can be separated with polar column in option

5- 502-2 US EPA Method: From water (striping) 60 compounds:

PURGE and TRAP system airmOzone A52022- 502-2 (Process MS in option)

6- VOC extraction from ground is also possible