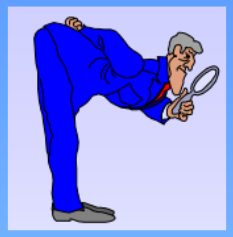
Metodi di laboratorio

inquinante	metodo	Tecnica analitica
PM_{10}	UNI EN12341:2014	**Gravimetrica**
$PM_{2.5}$	UNI EN12341:2014	**Gravimetrica**
Benzene	EN14662:2005 (1,2,4,5) UNI EN 14662:3-2015	**GC-FID**
As, Cd, Ni, Pb	UNI EN14902:2005	**ICP-MS or FAAS**
B(a)P	ISO 16362:2005* UNI EN 15549:2008	**GC-MS or HPLC fluorescenza**
EC/OC	UNI EN 16909:2017	**Trasmittanza termo ottica**
IONI in PM	UNI EN 16913: 2017	**Cromatografia ionica**

A Member State may also use any other methods which it can demonstrate give results equivalent to the above method.



Recovery efficiency

The recovery refers to whether or not the methodology measures all of the analyte that is contained in the sample. This is best evaluated by the measurements of reference materials or other samples of known composition. In this absence, spikes or surrogate may be added to the sampled matrix. The recovery is often stated as the percentage measured with respect to what was added.

Recovery in air samples

pollutant	Range of average recovery rates %	method
Pb	90 to 110	EN 14902:2005
Cd	90 to 110	EN 14902:2005
As	85 to 115	EN 14902:2005
Ni	85 to 115	EN 14902:2005
Ba P	80 to 120	EN 15549:2008
Benzene	> 90% as desorption efficiency	EN 14662-2:2005

2

blanks

Field blanks are clean samplers taken to the sampling site, handled in every way as the air samples, except that no air is drawn through them. Media blanks are simply unopened, new samplers which are sent with the samples (these blanks are not usually taken to the field).
It is also recommended that additional blind field blanks be sent along with the field samples, labeled as field samples, as a further check on the analysis. Blanks are good insurance to deal with contamination, but the best approach is to avoid sample contamination by being careful.

EN 14662-2 Benzene

Field blanks should be prepared by using tubes identical to those used for sampling and subjecting them to the same handling procedure as the samples except for the actual period of sampling. Label these as blanks.

EN 14902 methals

3.1.6
field filter blank
filter that is taken through the same procedure as a sample, except that no air is drawn through it. It is transported to the sampling site, mounted in the sampling unit, dismounted, returned to the laboratory and worked up in the same way as a sample

Method detection limit

Method detection limit (MDL) is lowest amount of analyte that is detectable using the method as , for example, determined by analysis of laboratory blanks.

Usually MDL shall be less than 10% of the limit value.

$$MDL = t_{n-1,\ 0.95} \times S_{lb}$$

$t_{n-1,\ 0.95}$ is the student factor for n measurements and 95% confidence interval

S_{lb} is the standard deviation of laboratory blanks

Too high MDLs can give a false overestimation of annual average.

In some analysis is too difficult to lower the analytical MDL, in these cases the sampling volume can be increased using high volume samplers.

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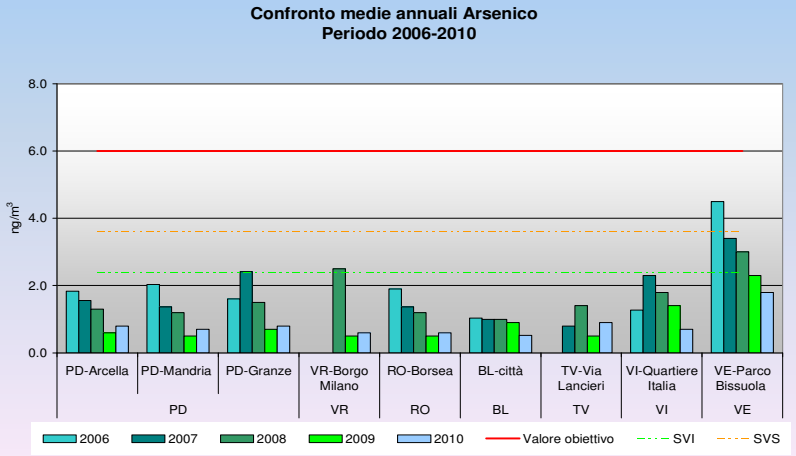
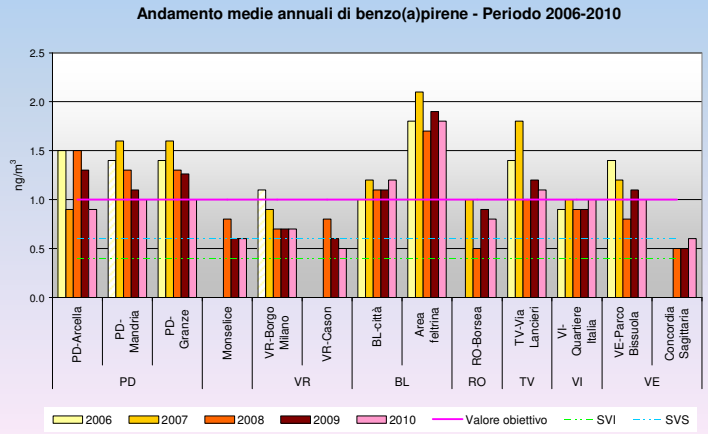
Cosa si determina nel particolato

Inquinante	Nome limite	Valore
Pb	Limite annuale per la protezione della salute umana	**0.5** µg/m^3
BaP	Valore obiettivo	**1.0** ng/m^3
Ni	Valore obiettivo	**20.0** ng/m^3
As	Valore obiettivo	**6.0** ng/m^3
Cd	Valore obiettivo	**5.0** ng/m^3

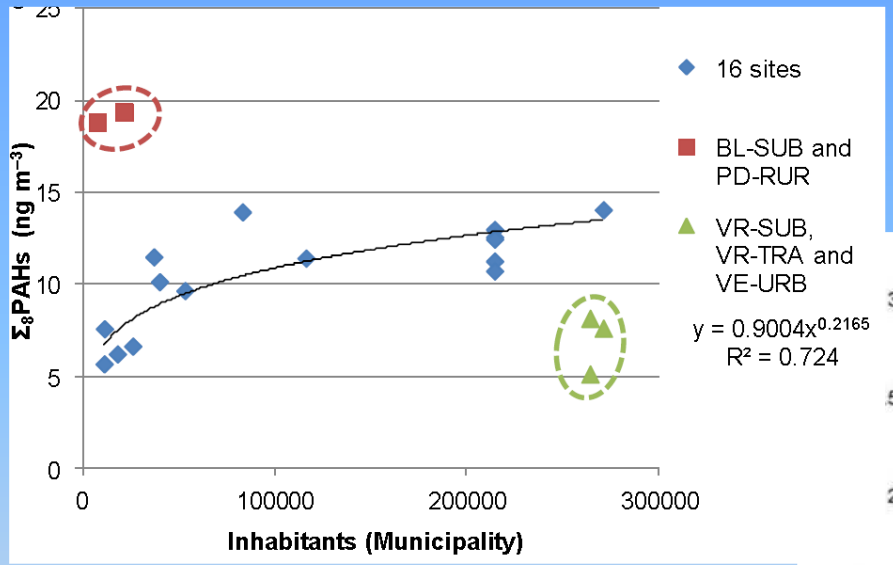


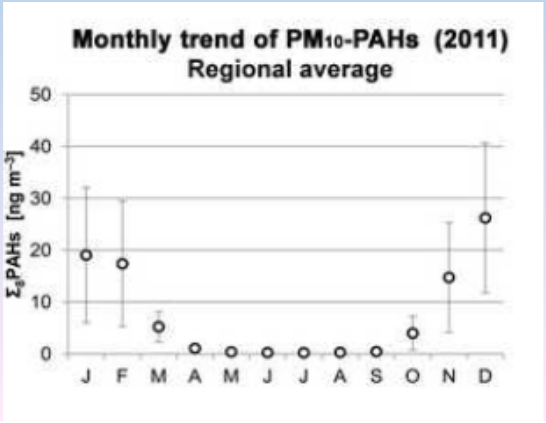


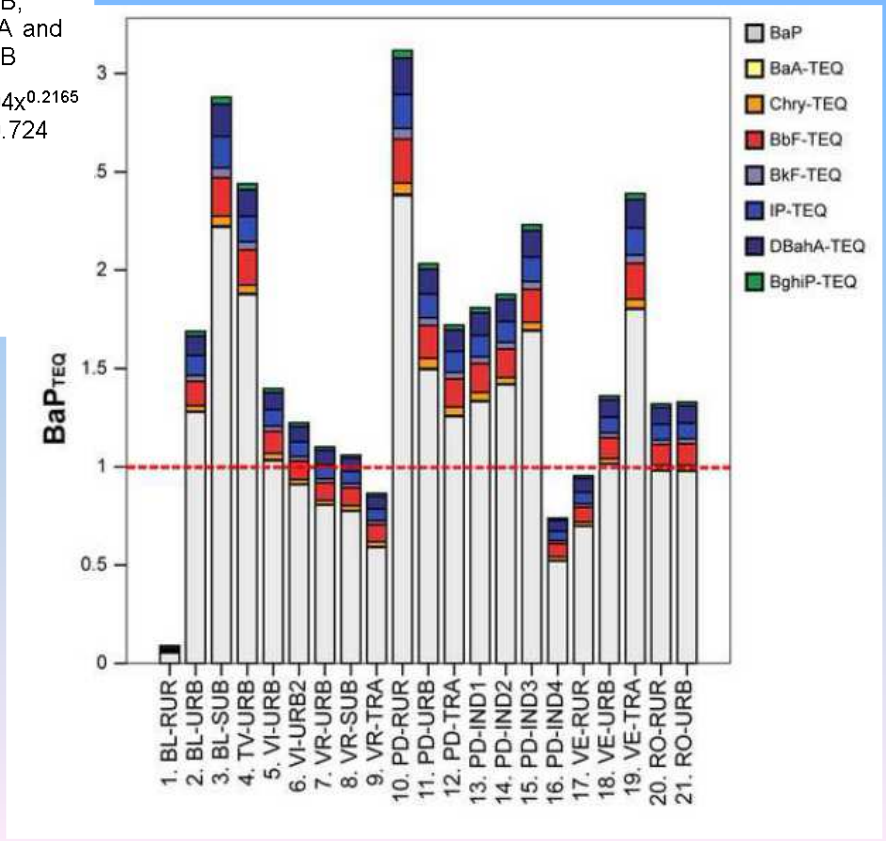
Caratterizzazione del PM

- HPLC per la determinazione degli IPA in particolare del B(a)P
  UNI EN 15549:2008
- ICP-MS o GAAS: per I metalli As, Ni, Cd, Pb; UNI EN 14902:2005
- Non ci sono limiti per il Hg, la percentuale più alta di questo metallo si trova in forma gassosa
- Cromatografia ionica per la determinazione degli ioni solubili in acqua $PM_{2.5}$;
- Carbonio organico e carbonio elementare su $PM_{2.5}$
- Analisi di specie marker es. Levoglucosano

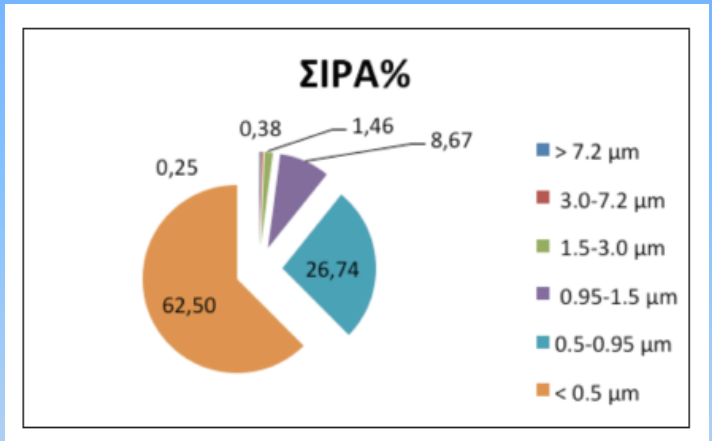
Gli IPA 2011

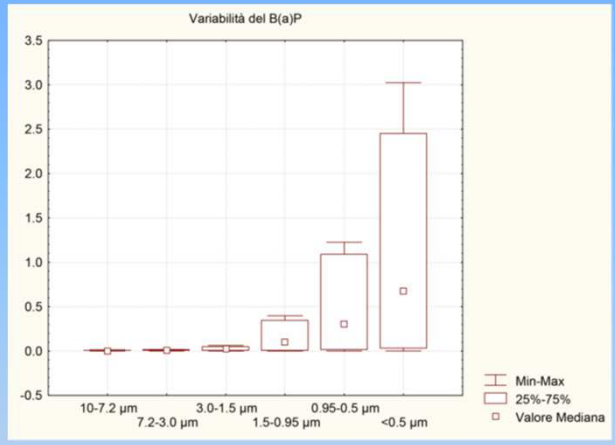

Σ8PAHs (ng m−3)
20
15
10
5
0
0
100000
200000
300000
Inhabitants (Municipality)
16 sites
BL-SUB and PD-RUR
VR-SUB, VR-TRA and VE-URB
y = 0.9004x0.2165
R² = 0.724


Monthly trend of PM10-PAHs (2011)
Regional average
Σ8PAHs [ng m−3]
50
40
30
20
10
0
J F M A M J J A S O N D

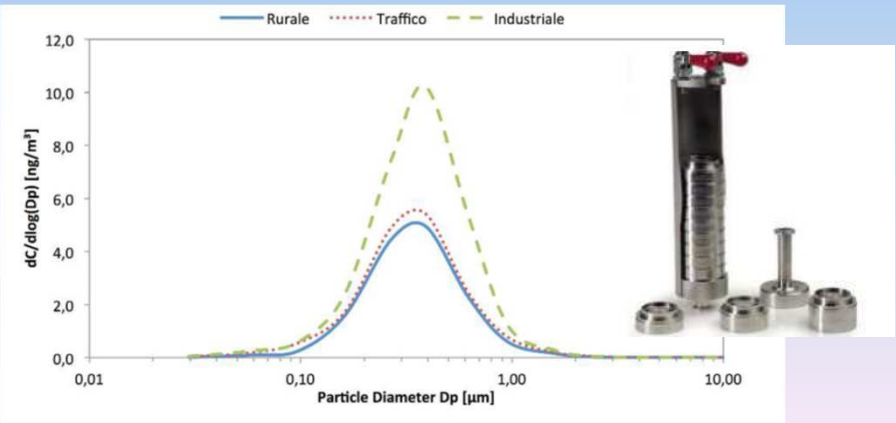

BaPTEQ
3
2.5
2
1.5
1
0.5
0
BaP
BaA-TEQ
Chry-TEQ
BbF-TEQ
BkF-TEQ
IP-TEQ
DBahA-TEQ
BghiP-TEQ
1. BL-RUR
2. BL-URB
3. BL-SUB
4. TV-URB
5. VI-URB
6. VI-URB2
7. VR-URB
8. VR-SUB
9. VR-TRA
10. PD-RUR
11. PD-URB
12. PD-TRA
13. PD-IND1
14. PD-IND2
15. PD-IND3
16. PD-IND4
17. VE-RUR
18. VE-URB
19. VE-TRA
20. RO-RUR
21. RO-URB

Ipa distribuzione dimensionale





La distribuzione dimensionale della concentrazione degli IPA analizzati è monomodale, centrata su 0,4 µm

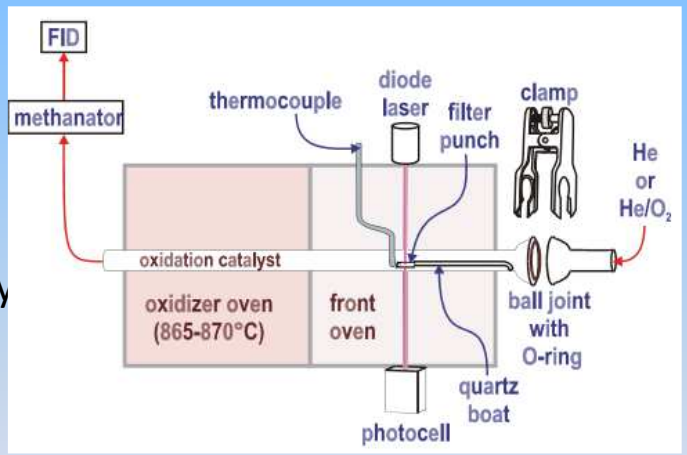


EUSAAR2 NIOSH Method: EC, OC, CC, TC

Thermal Optical transmittance:

All carbon evolving from the filter is oxidized to carbon dioxide, the carbon dioxide is reduced to methane, and the methane is measured using a flame ionization detector (FID). A red-light laser and photocell are used to monitor transmittance of the filter, which typically darkens as refractory OC chars during a non-oxidizing heat ramp and then lightens as the char burns off during an oxidizing heat ramp. The calculation software divides TC into OC and EC by setting the split time between the two as the time in the analysis when the transmittance of the filter returns (after darkening then lightening) to its original value at the beginning of the analysis.

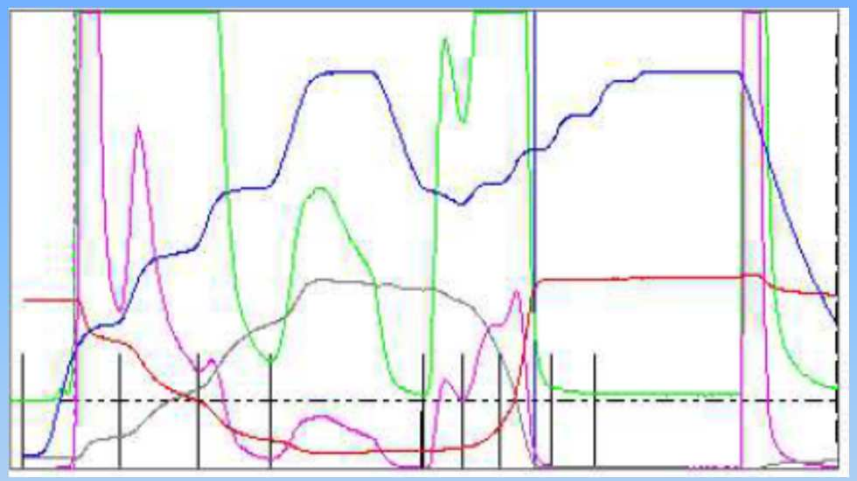
UNI EN 16909:2017



9

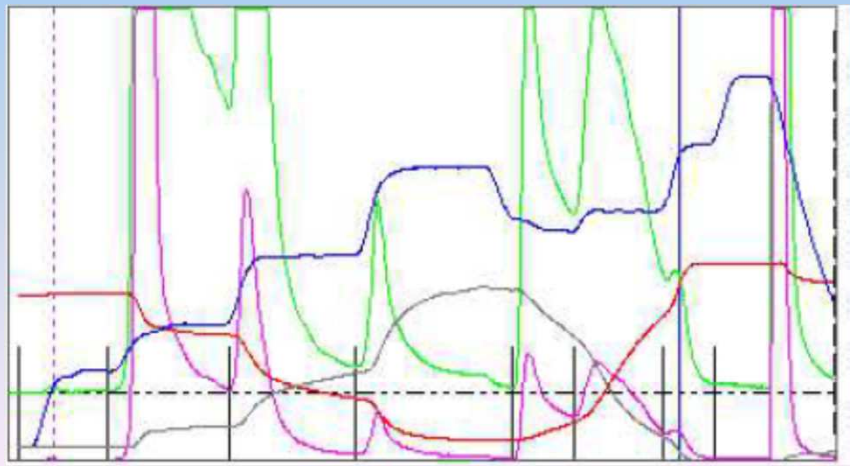
Output strumentale

NIOSH



Peak	ugC/sqcm	Fraction
OC1	28.3	0.568
OC2	9.5	0.192
OC3	2.2	0.045
OC4	2.7	0.054
OC5.....		
OC6.....		
EC1	1.4	0.028
EC2	2.6	0.052
EC3	2.9	0.058
EC4	0.1	0.001
EC5	0.0	0.001
EC6	0.1	0.002

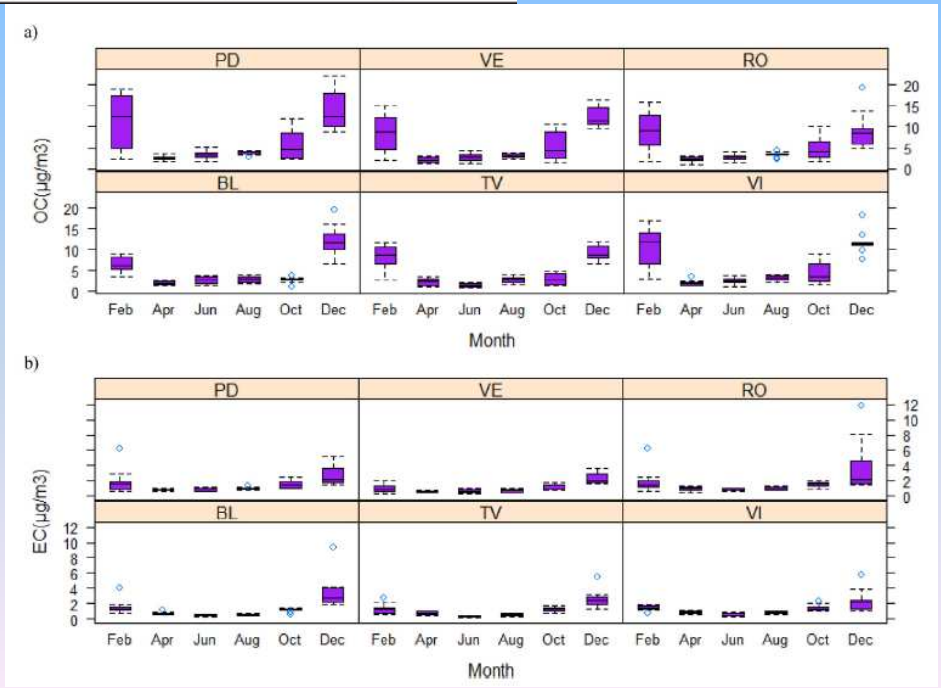
EUSAAR



Peak	ugC/sqcm	Fraction
OC1	0.0	0.001
OC2	33.6	0.659
OC3	7.0	0.138
OC4	1.4	0.028
OC5.....		
OC6.....		
EC1	3.0	0.060
EC2	5.1	0.100
EC3	0.7	0.013
EC4	0.1	0.002
EC5.....		
EC6.....		

EC/OC Alcuni dati

City	OC	EC
Helsinki	3	1.2
Budapest	6.8	3.3
Amsterdam	3.9–6.7	1.7–1.9
Barcelona	3.6–6.9	1.5–2.6
Birmingham		
Winter	3.7	1.2
Spring	2.8	0.6
Oslo	1.7	1
Athens	3.5	1.6
Paris	2.2	1.8
London/Oxford	1.4	1.3
Rome	3.7	2.3
Munich	2.7	0.5



OC EC in Veneto su PM2.5
2012/2013

Month	OC ($\mu g\ m^{-3}$)	EC ($\mu g\ m^{-3}$)	OC/EC
February	9.1	1.5	6.8
April	2.2	0.8	3.0
June	2.6	0.6	4.4
August	3.2	0.8	4.5
October	4.4	1.3	3.5
December	11.4	2.9	5.1
Annual	5.5	1.3	4.5

Province	OC $\mu g\ m^{-3}$	EC $\mu g\ m^{-3}$	OC/EC
Belluno	4.9	1.3	4.4
Treviso	4.5	1.1	4.5
Vicenza	5.8	1.3	4.6
Padova	6.8	1.5	4.7
Venice	5.7	1.1	5.4
RO	5.2	1.7	3.7
Provinces	5.5	1.3	4.5

POC-SOC

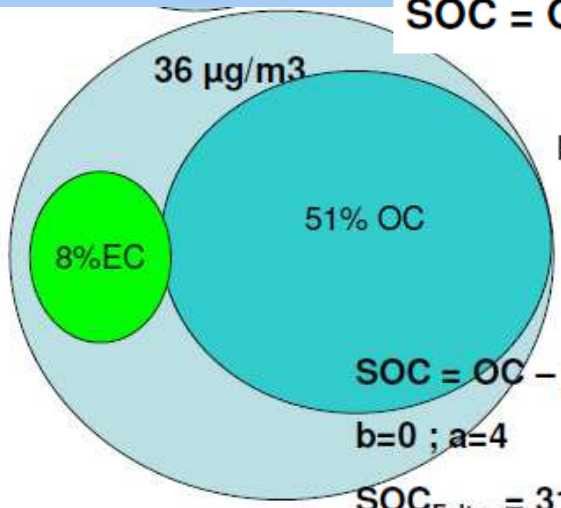
$$OC_{sec} = OC_{tot} - POC$$

$$POC = \sum_i a_i * EC_i + b$$

Dove *a* è il rapporto di ciascuna sorgente tra il POC ed EC, *b* è il carbonio non dovuto alla combustione e biogenico o di risospensione

TC = SOC + POC + EC

SOC = OC – [a*EC + b]

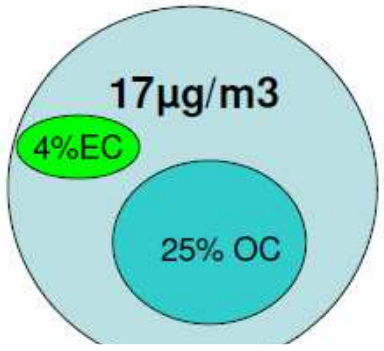


FE Inverno

SOC = OC – [a*EC + b]

b=0 ; a=4

SOC_{Feltre} = 31% =SOC_{legna}



RN Estate

SOC = OC – [a*EC + b]

b=0 ; a=0.5

SOC_{estate} = 23% =SOC_{diesel}

COV: definizioni

OMS

Descrizione	Abbreviazione	Intervallo di ebollizione (°C)
Composti organici molto volatili (gassosi)	VVOC	da < 50-100
Composti organici volatili	VOC	da 50- 240-260
Composti organici semivolatili	SVOC	da 240- 380-400
Composti organici associati al particolato	POM	>380

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ii) composto organico: qualsiasi composto contenente almeno l'elemento carbonio e uno o più degli elementi seguenti: idrogeno, alogeni, ossigeno, zolfo, fosforo, silicio o azoto, ad eccezione degli ossidi di carbonio e dei carbonati e bicarbonati inorganici;

ll) composto organico volatile (COV): qualsiasi composto organico che abbia a 293,15 K una pressione di vapore di 0,01 kPa o superiore, oppure che abbia una volatilità corrispondente in condizioni particolari di uso. Ai fini della parte quinta del presente decreto, è considerata come COV la frazione di creosoto che alla temperatura di 293,15 K ha una pressione di vapore superiore a 0,01 kPa;

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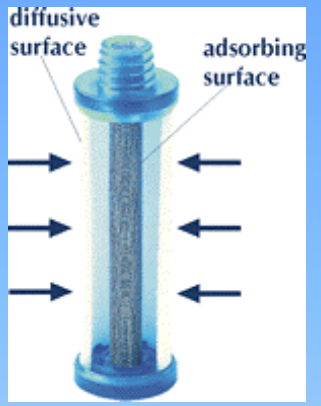
pp) composti organici volatili: tutti i composti organici diversi dal metano provenienti da fonti antropogeniche e biogeniche, i quali possono produrre ossidanti fotochimici reagendo con gli ossidi di azoto in presenza di luce solare;

Passive sampling

Section of radiello. Diffusive and adsorbing surfaces are cylindrical and coaxial: a large diffusive surface faces, at a fixed distance, the small surface of a little concentric cartridge.



Outdoor Shelter for Environmental/Ambient Air sampling

Radiello can be used to sample…

- VOCs – over 70 different volatile organic compounds, BTEX – benzene, toluene, ethylbenzene, o-xylene, m,p-xylene,
- O3 – ozone
- Aldehydes – acetaldehyde, acrolein, benzaldehyde, butanal, hexanal, formaldehyde, glutaric aldehyde, isopentenal, pentenal, and propanal
- NH3 – ammonia
- HCl and HF – hydrochloric acid and hydrofluoric acid
- NO2 and SO2 – nitrogen and sulfur dioxides
- H2S – hydrogen sulfide
- Phenols – phenol, methylphenol, and dimethylphenol

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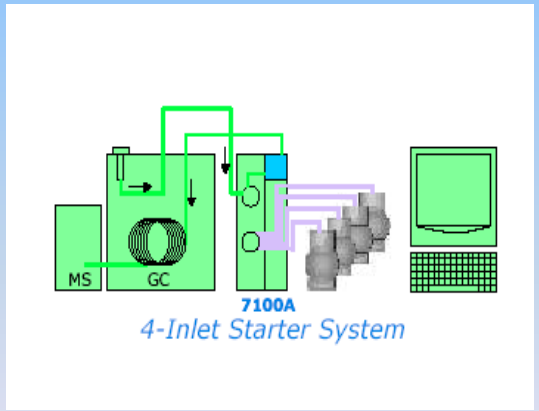
VOC captured by canister

Method TO-15 documents sampling and analytical procedures for the measurement of subsets of the 97 volatile organic compounds (VOCs) that are included in the 189 hazardous air pollutants (HAPs) listed in Title III of the Clean Air Act Amendments of 1990. VOCs are defined here as organic compounds having a vapor pressure greater than 10 Torr at 25°C and 760 mm Hg.



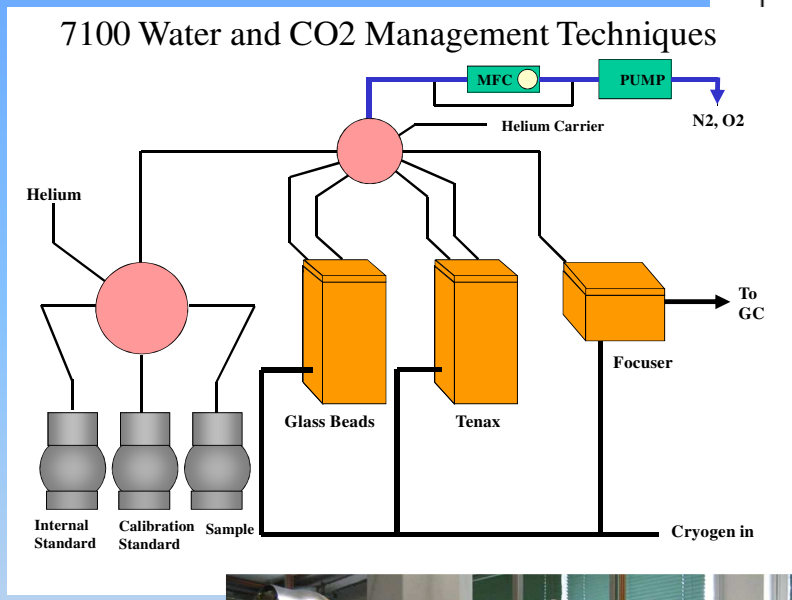
The use of canister:

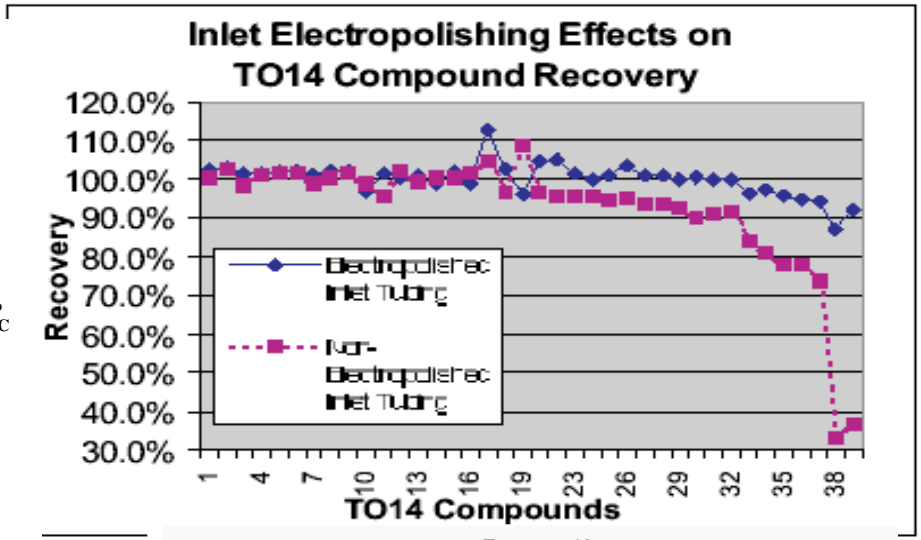
- Emergencies
- Industrial hygienist monitoring
- Odour
- Traffic pollution
- ……

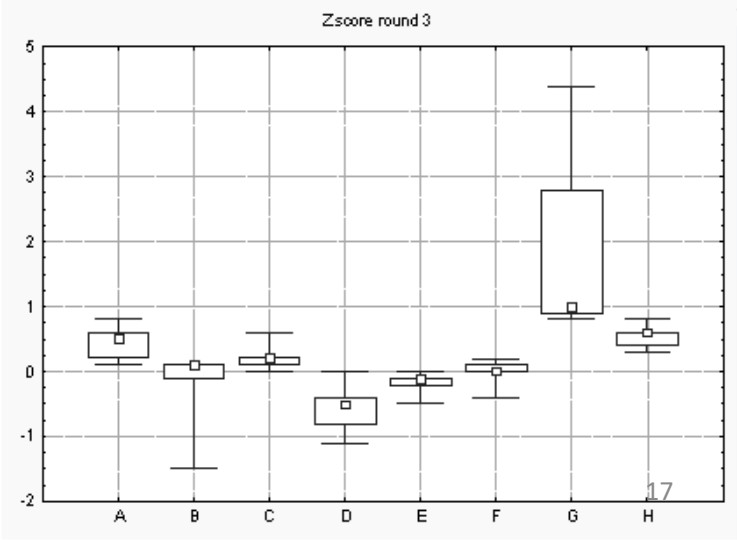
Sostanze riconosciute

1,1,2,2-Tetracloroetano	Clorobenzene
1,1,1-Tricloroetano	Cloroformio
1,1,2-Tricloroetano	Clorometano
1,1-Dicloroetilene	Cloruro di benzile
1,2,4-Triclorobenzene	Cloruro di etile
1,2,4-Trimetilbenzene	Cloruro di metilene
1,2-Diclorobenzene	Cloruro di vinile
1,2-Dicloroetano	Diclorodifluorometano
1,2-Dicloropropano	Diclorotetrafluoroetano
1,3,5-Trimetilbenzene	Etilbenzene
1,3-Butadiene	Isoottano
1,3-Diclorobenzene	m,p-Xilene
1,3-Dicloropropilene cis	Metiletilchetone
1,3-Dicloropropilene trans	Metilisobutilchetone
1,3-Esaclorobutadiene	n-Esano
Acetato di vinile	o-Xilene
Acetonitrile	Percloroetilene
Acrilonitrile	Stirene
Benzene	Tetracloruro di carbonio
Bromuro di etile	Toluene
Bromuro di metile	Tricloroetilene
	Triclorofluorometano
	Trifluorotricloroetano

EPA TO15


7100 Water and CO2 Management Techniques
MFC
PUMP
N2, O2
Helium Carrier
Helium
To GC
Focuser
Glass Beads
Tenax
Internal Standard
Calibration Standard
Sample
Cryogen in


Inlet Electropolishing Effects on TO14 Compound Recovery
Recovery
120.0%
110.0%
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
1
4
7
10
13
16
19
23
26
29
32
35
38
TO14 Compounds


Zscore round 3
5
4
3
2
1
0
-1
-2
A
B
C
D
E
F
G
H

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Deposition

The Sixth Community Environment Action Programme establishes the need to reduce pollution… to improve the monitoring and assessment of air quality including the **deposition** of pollutants…

Bulk samplers are polymer structures formed of a cylindrical container and a protection ring to avoid damage by birds and animals. The structure is clamped to a 60 mm pole. A Pyrex bottle with a funnel properly silanised (treated with dimethyldichlorosilane 5% in toluene) for dioxin or PE bottle for metals is placed in the support. Bulk sampling is extensively used, since these samplers are easier to operate than wet and dry ones, and can also be located at sites with no electrical power supply

UNI EN 15853: 2010 Standard method for the determination of **mercury** deposition
UNI EN 15841:2010 Standard method for the determination of **As, Cd, Pb Ni** deposition
UNI EN 15980:2011 Standard method for **PAH** deposition

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Alto volume: Diossine

In caso di incendio i processi di combustione sia controllati (inceneritori), sia incontrollati (incendi) sono indicati come una delle più rilevanti fonti di emissione di PCDD/F, qualora ci siano i precursori (fonti di carbonio e di cloro).

In caso di evento incidentale - in quasi tutti i processi industriali in cui si fa uso di cloro, le diossine possono rappresentare degli indesiderati prodotti di scarto, o altri settori industriali con produzione di pesticidi, coloranti, solventi clorurati…

Dettaglio modulo campionamento e cartuccia PUF con tappi

Altri metodi

PFAS	Molecular formula
PFOA	$C_8HF_{15}O_2$
PFHxA	$C_6HF_{11}O_2$
4:2 FTOH	$C_6H_5F_9O$
6:2 FTOH	$C_8H_5F_{13}O$
PFDA	$C_{10}HF_{19}O_2$
10:2 FTOH	$C_{12}H_5F_{21}O$
7:2 sFTOH	$C_9H_5F_{15}O$
PFHpA	$C_7HF_{13}O_2$
PFTeDA	$C_{14}HF_{27}O_2$
PFPeA	$C_5HF_9O_2$
PFNA	$C_9HF_{17}O_2$
PFDoA	$C_{12}HF_{23}O_2$
PFHxDA	$C_{16}HF_{31}O_2$
5:2 sFTOH	$C_7H_5F_{11}O$
PFTrDA	$C_{13}HF_{25}O_2$
PFUdA	$C_{11}HF_{21}O_2$
N-MeFOSA-M	$C_9H_4F_{17}NO_2S$
N-EtFOSA-M	$C_{10}H_6F_{17}NO_2S$
N-MeFOSE-M	$C_{11}H_8F_{17}NO_3S$
PFODA	$C_{18}HF_{35}O_2$
8:2 FTOH	$C_{10}H_5F_{17}O$

TD:

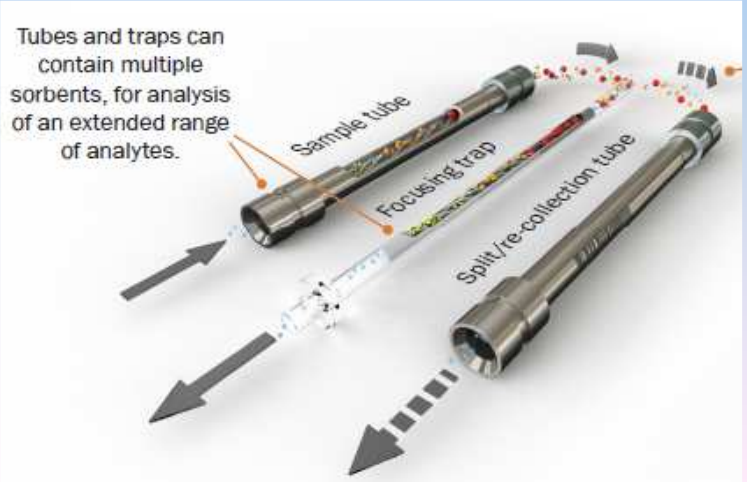
Sorbent tubes:	Universal tubes (C3-AAXX-5266)
TD instrument:	TD100-xr™ (Markes International)
Flow path:	180°C
Tube desorption:	300°C (8 minutes) at 75 mL/min
Focusing trap:	'Air Toxics' (U-T15ATA-2S)
Trap low:	25°C
Trap desorption:	300°C (4 minutes)
Trap outlet split flow:	6 mL/min

GC:

Column:	DB-VRX (Agilent Technologies) 60 m x 0.25 mm x 1.4 µm
Column flow:	1.2 mL/min, helium
Oven:	35°C (5 min), 10°C/min, 230°C (15 min)

Quadrupole MS:

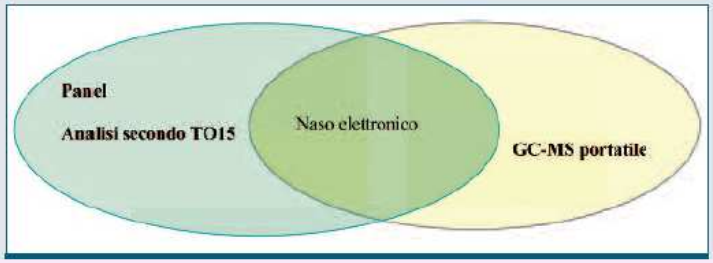
Scan mode:	m/z 35–350

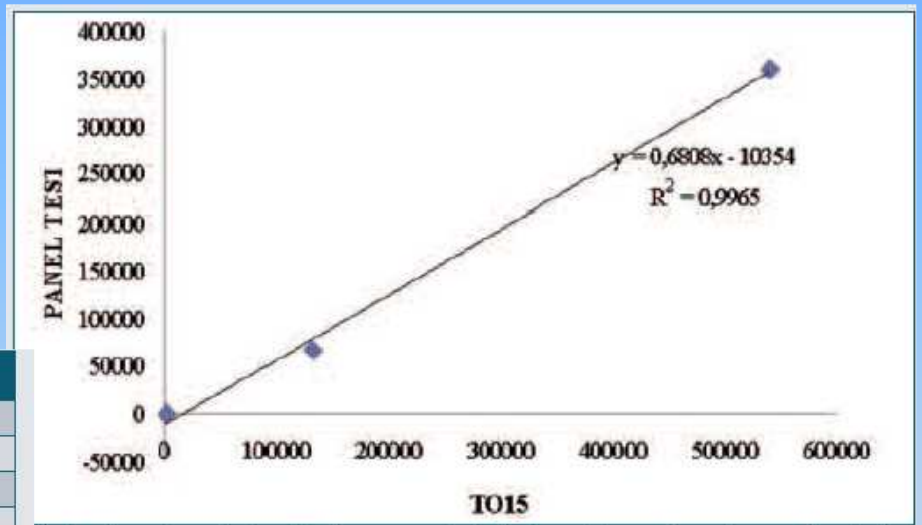


Analisi degli Odori: tecniche

	SENSIBILITÀ[1]	MISURA EFFETTO OLFATTIVO[2]	SELETTIVITÀ[3]	TEMPO DI ANALISI
Analisi TO15	Buona	Scarsa	Buona	Medio
GC MS portatile	Media	Scarsa	Buona	Buono
Panel	Buona	Buona	Nulla	Medio
Naso elettronico	Buona	Buona	Nulla	Buono

[1]Sensibilità: capacità d'individuare composti a bassissima concentrazione
[2]Misura effetto olfattivo: capacità di rilevare composti responsabili dell'effetto odorigeno od osmogeno
[3]Selettività: facoltà di discriminare i singoli analiti





ig. 1 - In ascissa è riportata la sommatoria delle sostanze ritrovate con il metodo
PA TO15 moltiplicate per il fattore che tiene conto della soglia olfattiva,
ordinata il valore odorigeno degli stessi campioni esaminati mediante
N 13725:2003

Odori: norme tecniche

EN 16841-1:2016 describes the grid method for the determination of the level of odour exposure in ambient air within a defined assessment area. The method relies on qualified human panel members to determine the distribution of the frequency of odour exposure over a sufficiently long period (6 or 12 months) to be representative of the meteorological conditions of that location. The sources of the odorant under study may be located within or outside the assessment area.

EN 16841-2:2016 describes the plume method for determining the extent of recognisable odours from a specific source using direct observations in the field by human panel members under specific meteorological conditions (i.e. specific wind direction, wind speed and boundary layer turbulence) The results are typically used to determine a plausible extent of potential exposure to recognisable odours or to estimate the total emission rate using reverse dispersion modelling.

Standard	Title
EN 13725:2003	Air quality - Determination of odour concentration by dynamic olfactometry
EN 16841-1:2016	Ambient air - Determination of odour in ambient air by using field inspection - Part 1: Grid method
EN 16841-2:2016	Ambient air - Determination of odour in ambient air by using field inspection - Part 2: Plume method

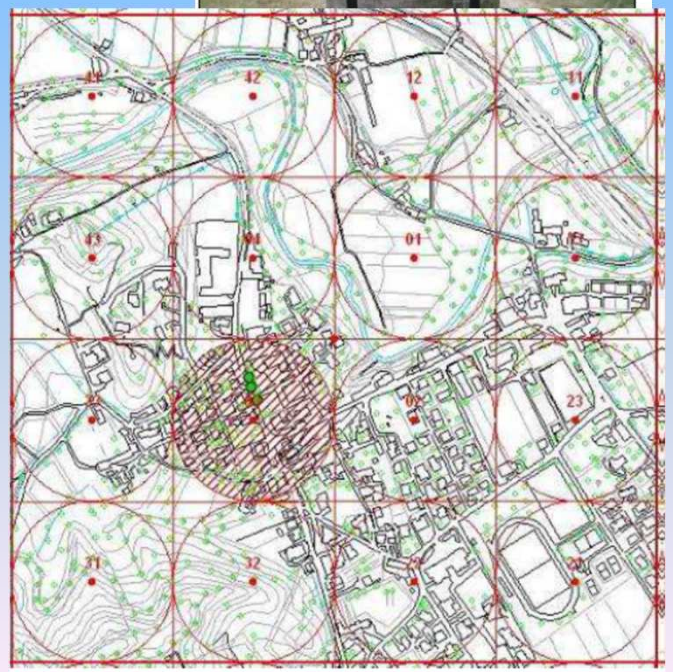
Biomonitoraggio

- le tecniche di bioindicazione che stimano le alterazioni morfologiche, fisiologiche o genetiche a livello di organismi o le modificazioni nella composizione delle comunità animali o vegetali, indotte dalle variazioni ambientali;

- le tecniche di bioaccumulo che si avvalgono di organismi in grado di assorbire ed accumulare, con alto livello di tolleranza, sostanze più o meno tossiche (es. metallipesanti) le cui concentrazioni vengono misurate.

Licheni come bioindicatori

- Assenza di cuticola: contatto diretto con l'atmosfera
- Attivi tutto l'anno in particolare dopo ogni pioggia
- Dipendono dall'aria per il nutrimento
- Assenza di sistemi di regolazione degli scambi
- Riproduzione mediante strutture aerodiffuse (soradi, isisidi, spore.
- Contatto diretto con gli inquinanti
- Crescita lenta



Metodi strumentazione automatica

inquinante	metodo	Tecnica analitica
SO_2	UNI EN 14212:2012	**Ultraviolet fluorescence**
NO_2	UNI EN 14211:2012	**chemiluminescence**
CO	UNI EN14626:2012	**non-dispersive IR spectroscopy**
O_3	UNI EN14625:2012	**Ultraviolet photometry**

A Member State may also use any other methods which it can demonstrate give results equivalent to the above method.