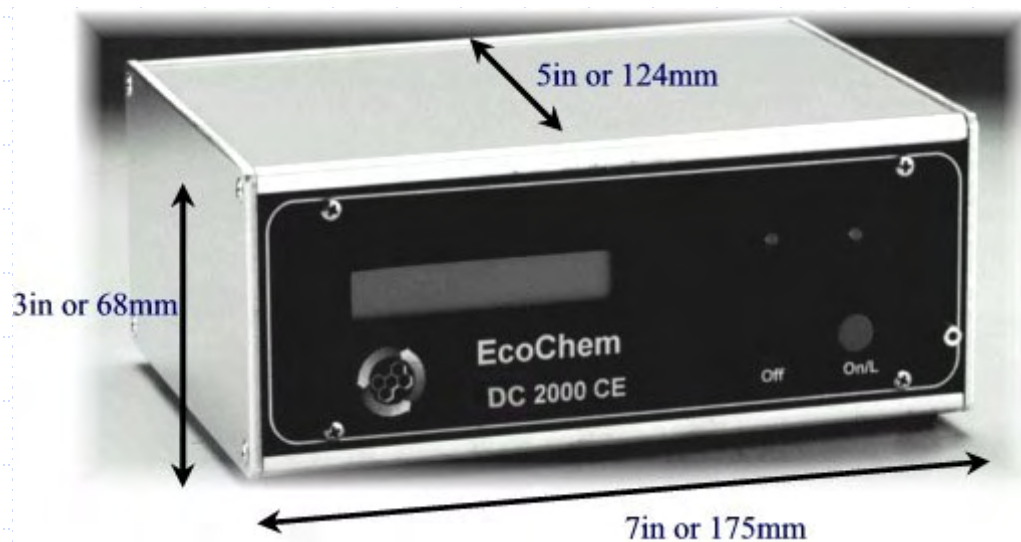


Introduction to the Handheld Photoelectric Aerosol Sensor and the Diffusion Charger



EcoChem Analytics

Presentation Outline

- ◆ Safety Warnings & Precautions
- ◆ Working Principle
- ◆ Health Risk Perspective
- ◆ Analyzer Operations
 - Description of Instrument
 - Software
- ◆ Service and Maintenance
- ◆ Applications



Safety Warnings and Precautions



ATTENTION

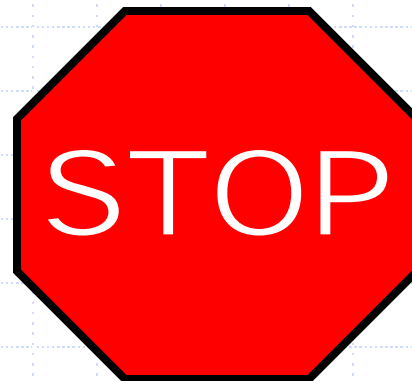


Safety Warnings & Precautions!

1. Never operate the instrument if the **cover is removed**.
2. Maintenance and repair work should only be done by **trained personnel**.
3. Care should be taken under extremely **humid conditions!**
The monitor should be prevented from becoming wet.
(If the sensor got wet and is not working properly, it should be placed into a dry place and left there for 1-2 days. This may restore the proper functioning.)



ATTENTION

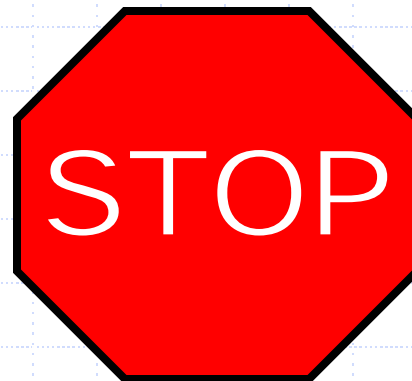


Safety Warnings & Precautions (Contd.)

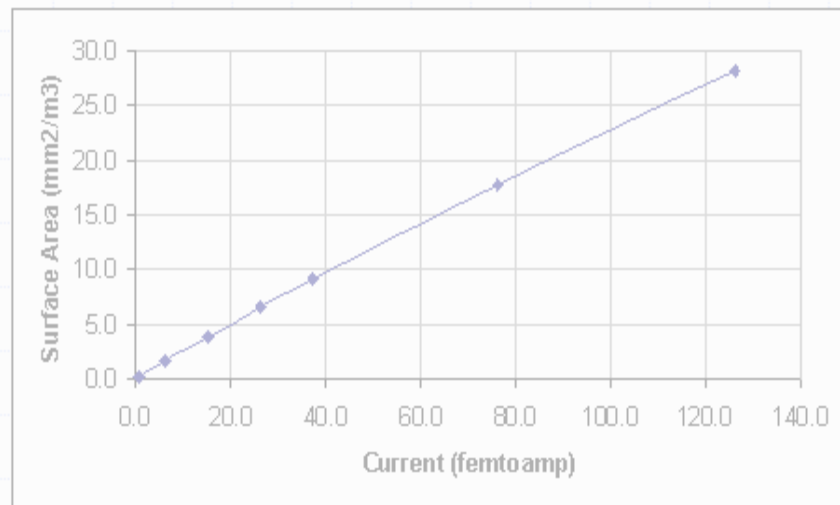
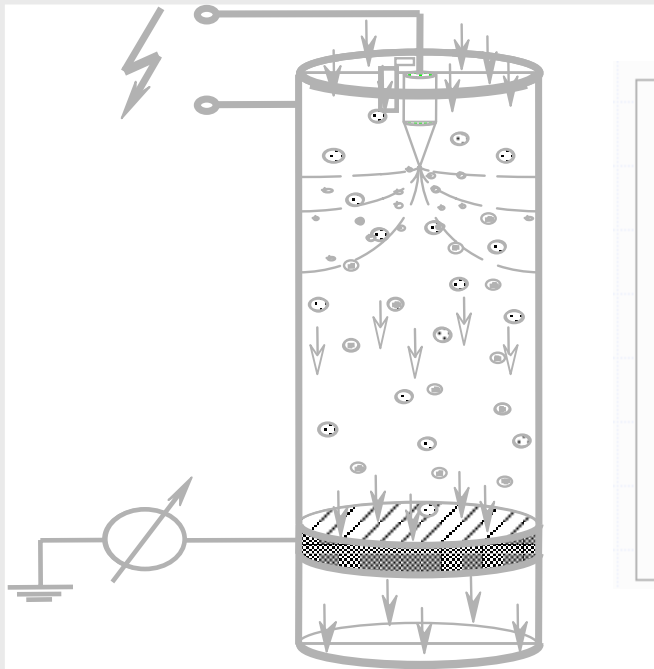
4. Do not expose the instrument directly to rain or snow!
5. Always use the original serial cable supplied with the analyzer for downloading data.
6. Do not substitute the analyzer power supply with a standard laptop power supply (though they may look similar). You will seriously damage the analyzer by using an incompatible power supply unit.



ATTENTION



Working Principle



Focus of Attention...



DC 2000CE measures
PARTICLE SURFACE AREA



PAS 2000CE measures
PARTICLE PAH / SOOT

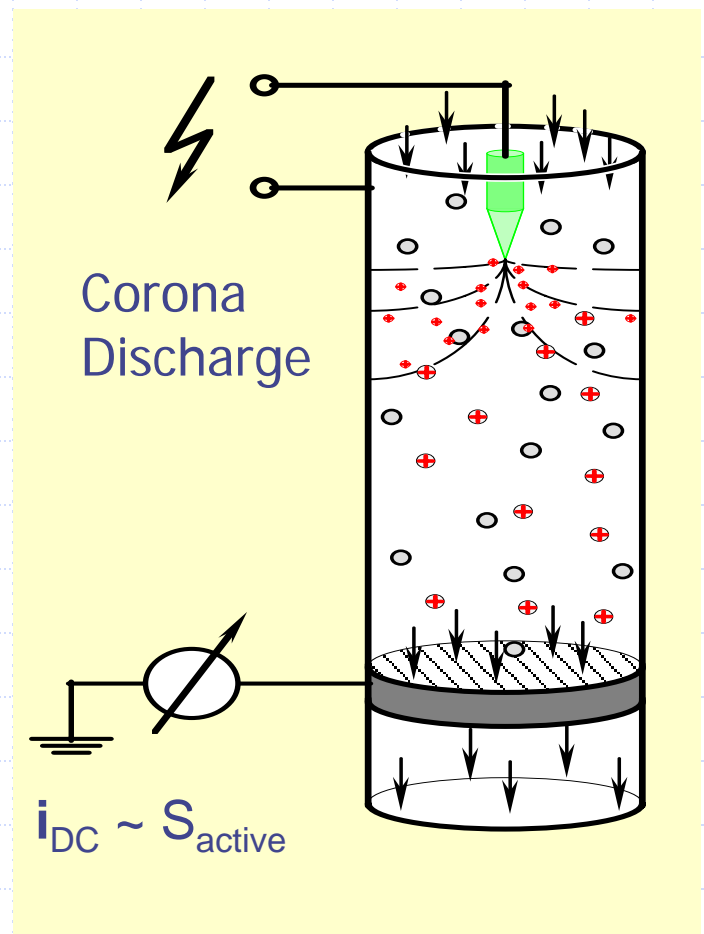
Diffusion Charger (DC 2000CE)



- Particle surface area
- Large particle size range
- Fast response, high sensitivity
- Compact, rugged and user-friendly

Principle of the Diffusion Charger (DC)

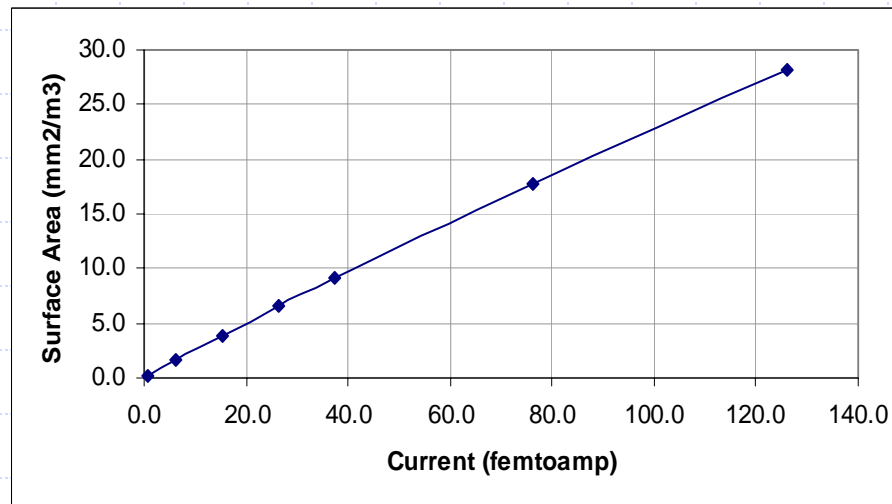
- Corona discharge is used to produce ions in the carrier gas
- Ions attach to particle surface by diffusion
- Collect particles in an electrically insulated filter
- Measure electric current flowing from filter (resolution ~1 femtoamp)



i_{DC} = DC Current
 S_{active} = Particle active surface area

What does the DC measure...

- ◆ The diffusion chargers measures the **particle Active Surface Area (mm²/m³)**
- ◆ The Active Surface Area is defined as the particle area accessible for impinging molecules of the carrier gas. It is surface upon which transfer of momentum, energy and mass from the gas to the particle takes place.



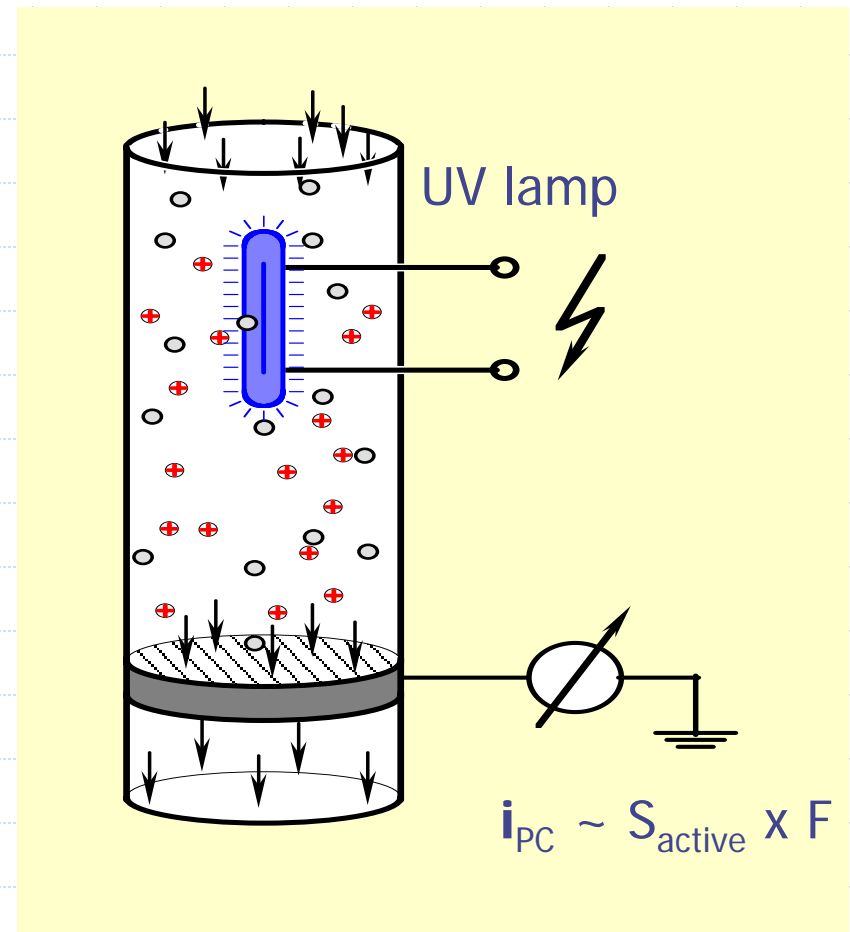
Photoelectric Aerosol Sensor -- PAS 2000CE



- Sensitive to surface chemistry
- Responds to ultrafine carbon particles
- High sensitivity, large measurement range
- Light, compact and field-ruggedized

Principle of the Photoelectric Aerosol Sensor (PAS)

- Excimer lamp used to produce UV radiation
- Photoionization of carbonaceous particles
- Collect particles in an electrically insulated filter
- Measure electric current flowing from filter (resolution ~1 femtoamp)

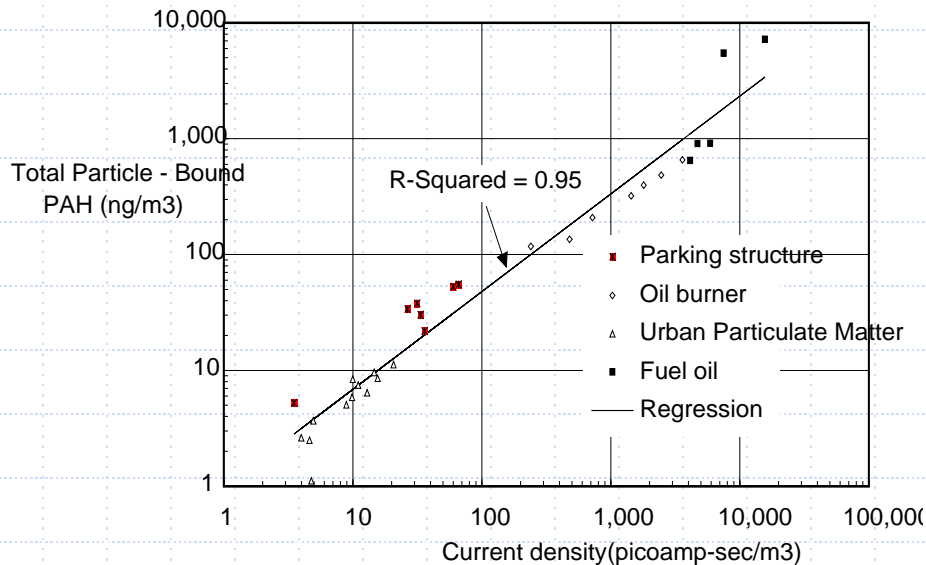


I_{PAS} = PAS Current
 S_{active} = Particle active surface area
 F = Surface chemistry factor

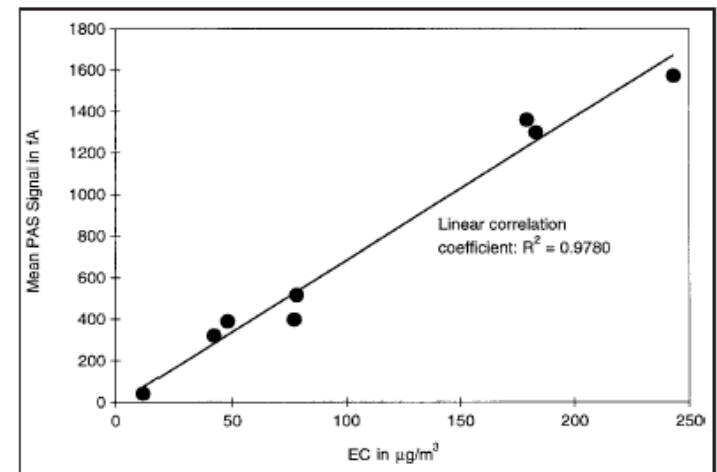
What does the PAS measure...

The PAS analyzer estimates **TOTAL PARTICLE BOUND PAH**. The analyzer signal has also been correlated to other related compounds like **Soot**, **Elemental Carbon** and **Black Carbon**.

PAH

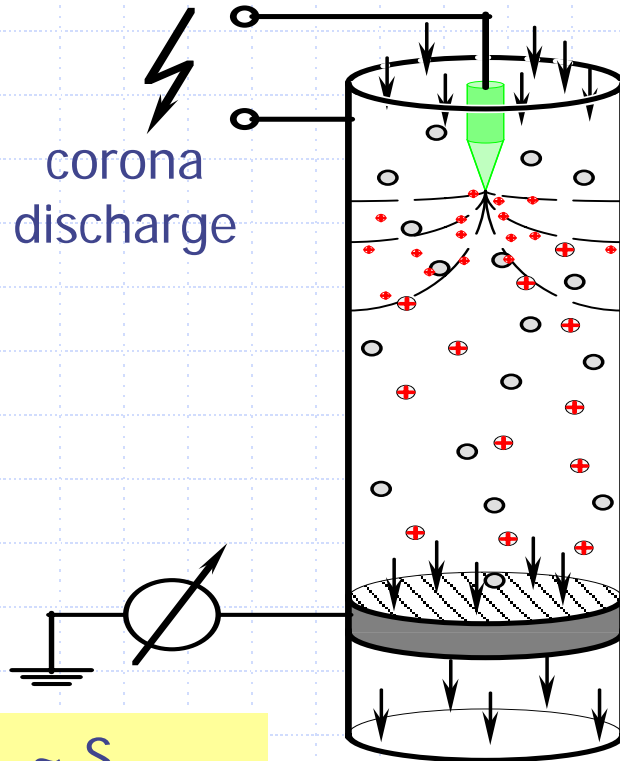


Elemental Carbon



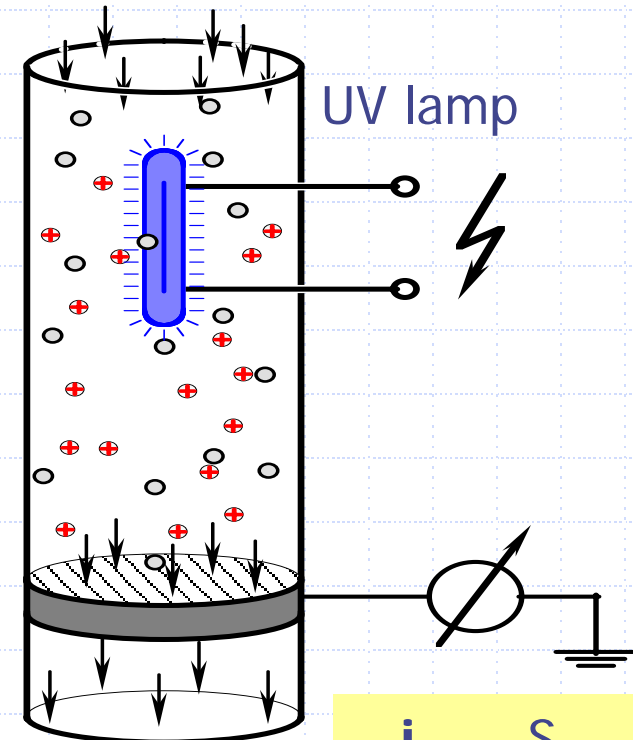
Complementary Measurements

Diffusion Charger
DC 2000CE
(PARTICLE SURFACE AREA)



$$i_{DC} \sim S_{active}$$

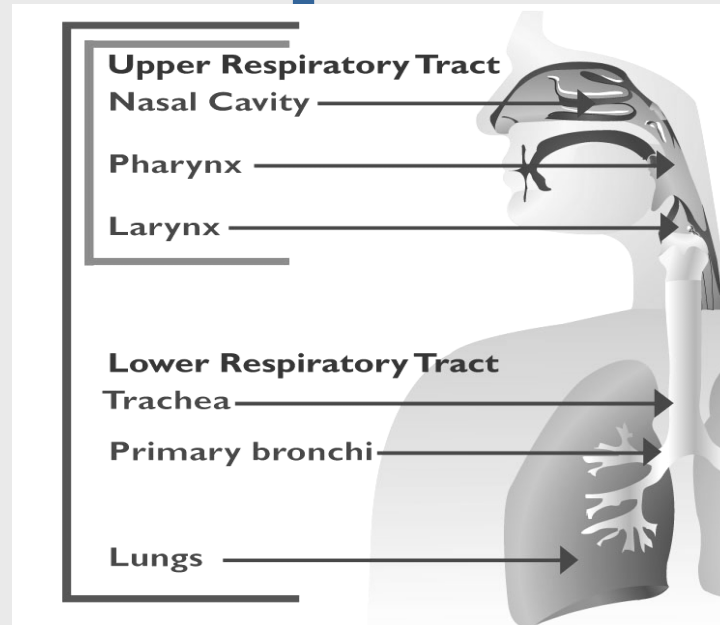
Photoelectric Aerosol Sensor
PAS 2000CE
(PARTICLE PAH/SOOT)



$$i_{PC} \sim S_{active} \times f$$

Working Principle

Health Risk Perspective

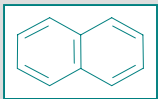


What are PAH

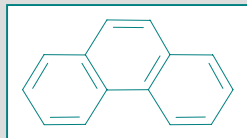
- ◆ PAH – are POLYCYCLIC AROMATIC HYDROCARBONS ... also frequently referred to as Polynuclear Aromatic Compounds (PNA)
- ◆ PAH are primarily products of incomplete combustion

TYPICAL PAH COMPOUNDS

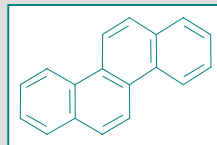
Naphthalene



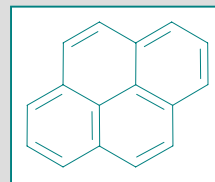
Phenanthrene



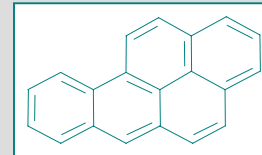
Chrysene



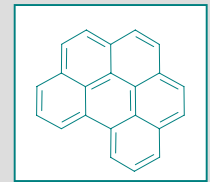
Pyrene



Benzo(a)pyrene



Benzo(g,h,i)perylene



Why measure PAH Compounds

- ◆ The U.S. Department of Health and Human Services has determined that PAHs may reasonably be anticipated to be carcinogens.
- ◆ Several of the PAHs, including benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, have caused tumors in laboratory animals when they ate them, when they were applied to their skin, or when they breathed them in the air for long periods of time.
- ◆ Reports in humans show that individuals exposed by breathing or skin contact for long periods of time to mixtures of other compounds and PAHs can also develop cancer.

ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

[Search](#) | [Index](#) | [Home](#) | [Glossary](#) | [Contact Us](#)

CONTENTS

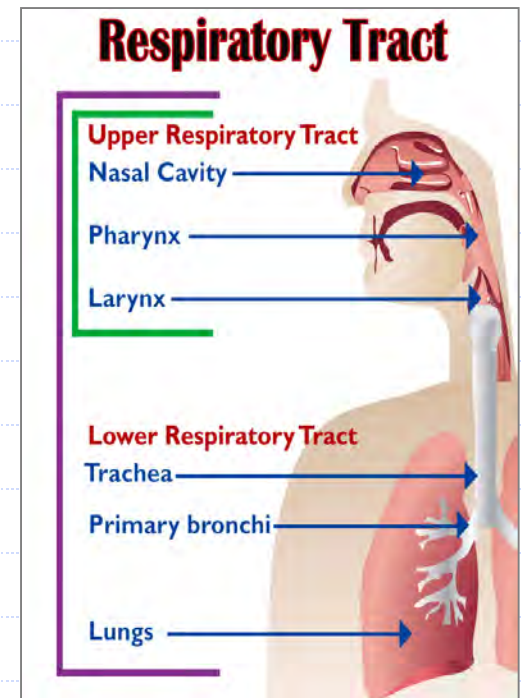
- [Summary](#)
- [What are polycyclic aromatic hydrocarbons](#)

September 1996

ToxFAQs™
for
Polycyclic Aromatic Hydrocarbons (PAHs)
(Hidrocarburos Aromáticos Policíclicos (HAPs))

Why measure Particle Surface Area

- ◆ Ultrafine particles act as carriers of toxic compounds (like PAH) and are transported to the lower respiratory tract.
- ◆ Ultrafine particles have an extremely large surface area which is not adequately reflected by taking a particle weight measurement (traditional method for estimating particle concentration).
- ◆ Health risk posed by ultrafine particles is more related to measurement of the Particle surface area since the particle surface is a better measure of estimating the amount of toxic compounds that can be transported by the ultrafine particles.



Why use a combination of Instruments

The combination of the Photoelectric Aerosol Sensor (PAS 2000CE) which measures **particle chemistry (PAH)** and the Diffusion Charger (DC2000CE) which measures **particle surface area** provides an **approximate estimate of the health risk** posed by exposure to ultrafine particles.



Surface Area

+



Surface Chemistry

=

Estimate of
ultrafine particulate
health risk

Analyzer Operations



Front Panel

Digital Display (LCD) Power Supply (LED) Operation Status (LED)

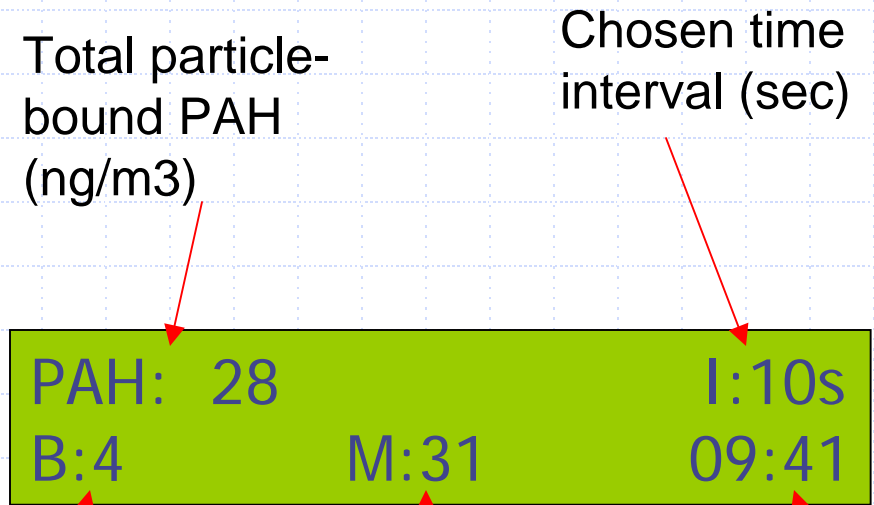


Air Intake

OFF switch

ON switch along with Illumination of digital display

LCD on Front Panel



Total particle-bound PAH (ng/m3)

Chosen time interval (sec)

PAH: 28

I:10s

B:4

M:31

09:41

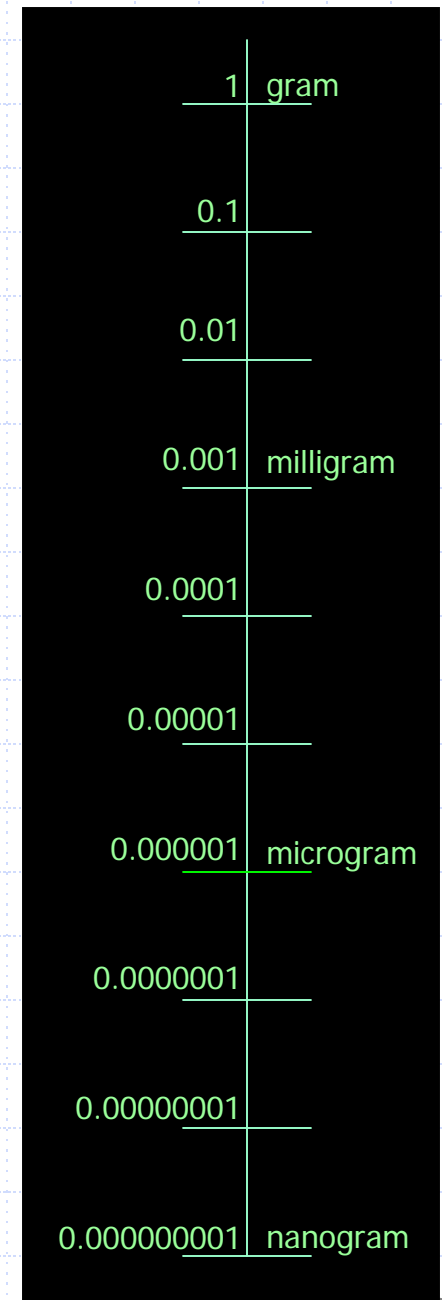
Battery charge (0 to 9)

Memory pointer (%)

Time (HH:MM)

Instrument Readings

- ◆ Measurements made by the PAS 2000CE are ng/m^3 (nanogram per cubic meter) of PPAH (particle-bound PAH)
- ◆ Measurements made by the DC 2000CE represent mm^2/m^3 (millimeter squared per cubic meter) of particle surface area



Front Panel Diagnostic Messages

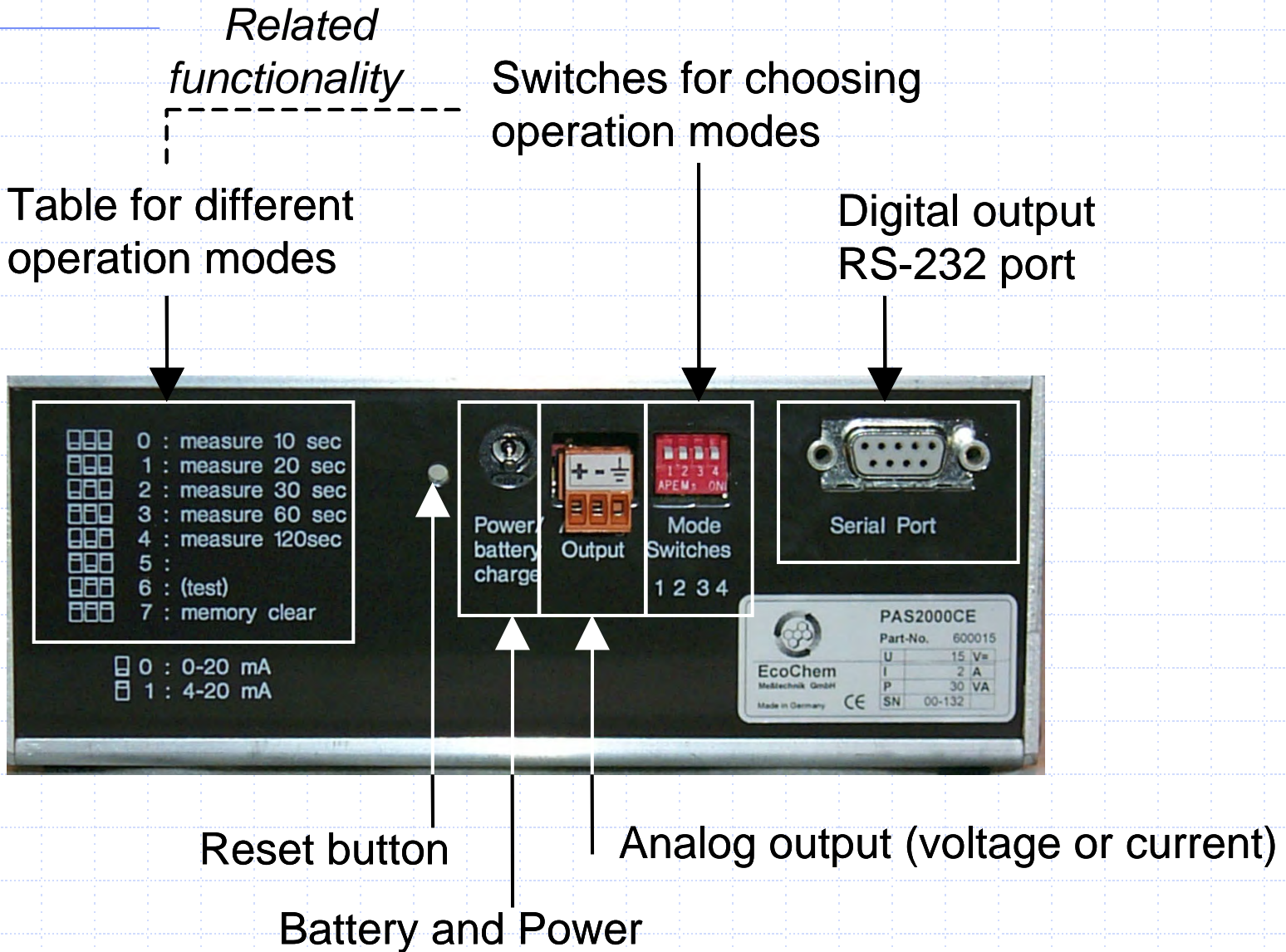
A exclamation mark "!" next to the memory number indicates that the memory is filled and new data values are overwriting old ones.

The battery charge level is a "normalized" number between 10 ("fully charged") and 0 ("no charge")



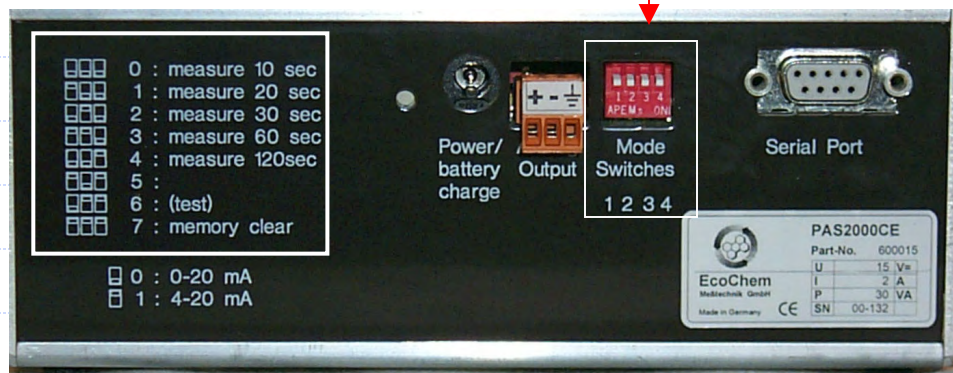
PAH: 28	I:10s
B:4	M:31!
	09:41

Back Panel



Measurement Modes

Mode	Storage time interval	Measurement and display time interval	Resolution of measurement
0	10 sec.	5 sec.	30 sec.
1	20 sec.	5 sec.	30 sec.
2	30 sec.	5 sec.	30 sec.
3	60 sec.	10 sec.	60 sec.
4	120 sec.	20 sec.	120 sec.



Back Panel of Instrument

Analyzer Operations

Choice of Measurement Mode

Mode	Storage time interval	Measurement and display time interval	Resolution of measurement
0	10 sec.	5 sec.	30 sec.
1	20 sec.	5 sec.	30 sec.
2	30 sec.	5 sec.	30 sec.
3	60 sec.	10 sec.	60 sec.
4	120 sec.	20 sec.	120 sec.

- Modes 0 - 2 offer **high time resolution** data
- Modes 3 – 4 **increase the total time interval** that can be stored in the internal memory of the instrument
- Choose a mode that is **optimum** for your application!

Starting and Terminating a Measurement

Press ON/L button for Starting

ON – for starting a measurement

L – “Light” digital display is lit when switch is pressed

Press OFF button for Terminating

There maybe a slight time delay in shutdown after the OFF switch is pressed



Recording a Measurement

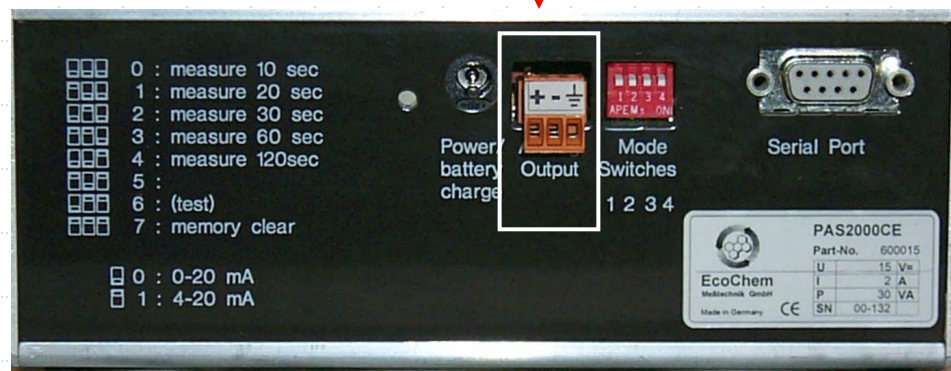
- Values are automatically written in the internal memory of the instrument. The internal memory is approximately 8000 data points
- If you wish to collect real-time data using the analog outputs (current or voltage) you have to connect the instrument to external power.

Analog Output Scaling

PAS 2000CE: 0-4000 ng/m³ corresponds to 0-10 volts or 0-20 mA

DC 2000CE: 0-1000 mm²/m³ corresponds to 0-10 volts or 0-20 mA

Back Panel of Instrument



Software Installation

- ◆ Move software from CD-ROM to PC
- ◆ No installation program – simply **COPY** files from CD-ROM to hard disk
- ◆ Establish a shortcut to the **AIRQUAL** program



Airqual.exe



Airqual.exe

Communicating with the Instrument

Use the serial cable provided with instrument to connect PC to analyzer

Analyzer Operations

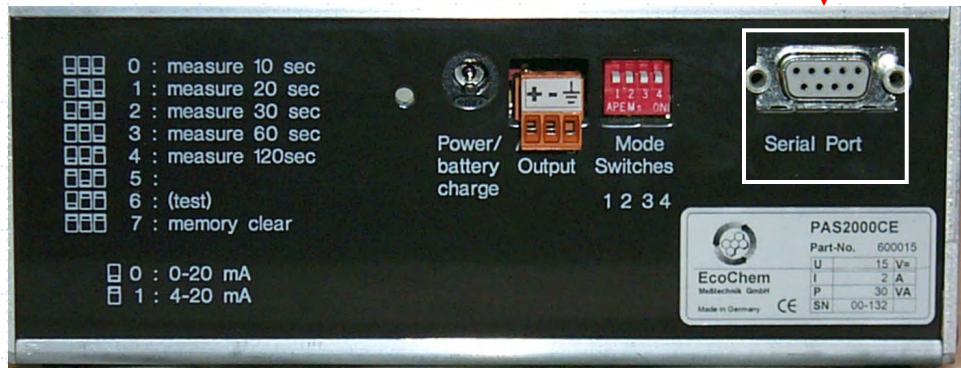


Computer



Serial cable

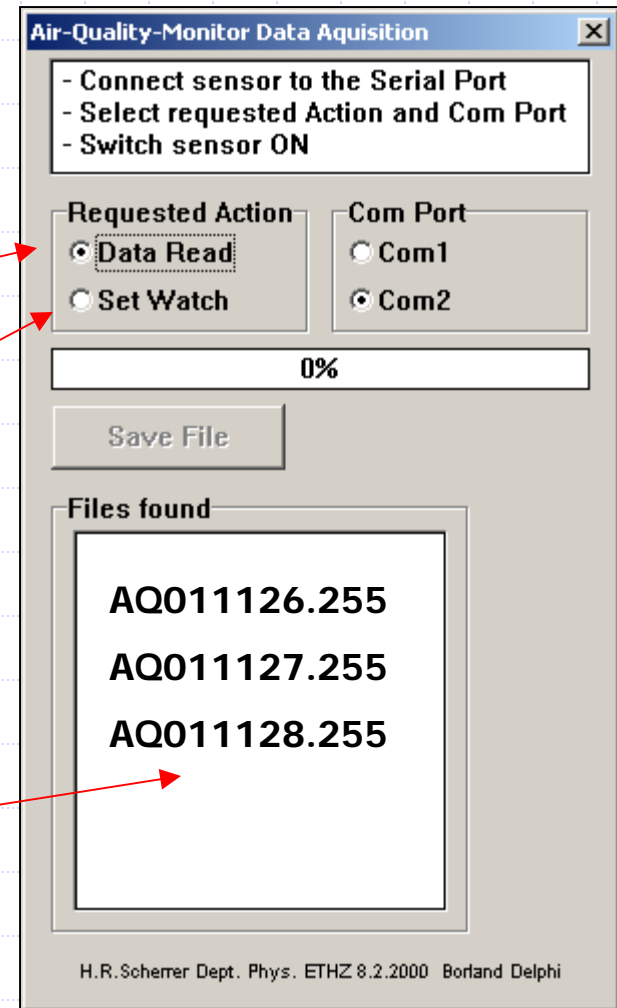
Back Panel of Instrument



Software Overview

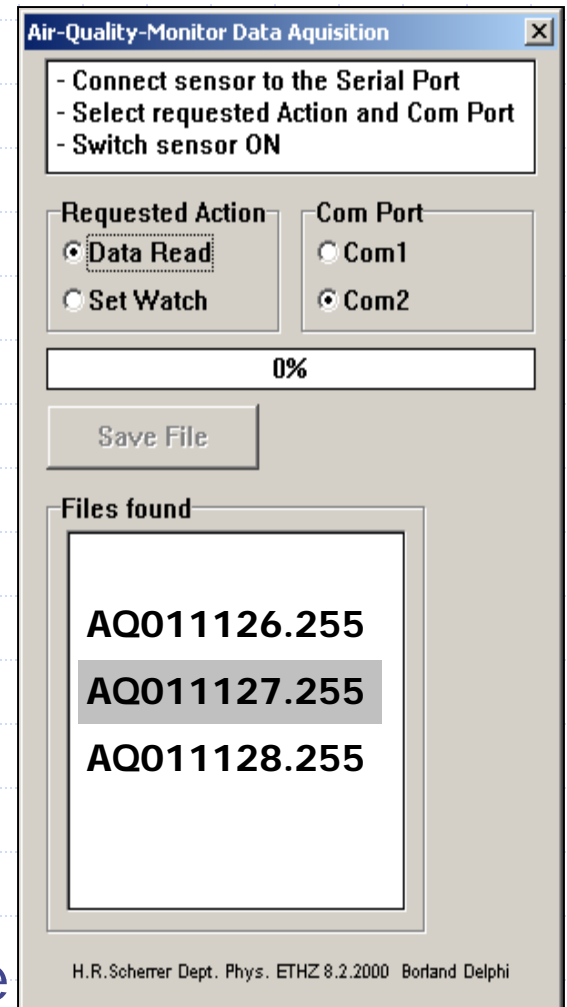
- ◆ Run AIRQUAL
- ◆ Use program to DOWNLOAD DATA
- ◆ Use to set TIME and DATE

This box will contain data file names that exist on your analyzer



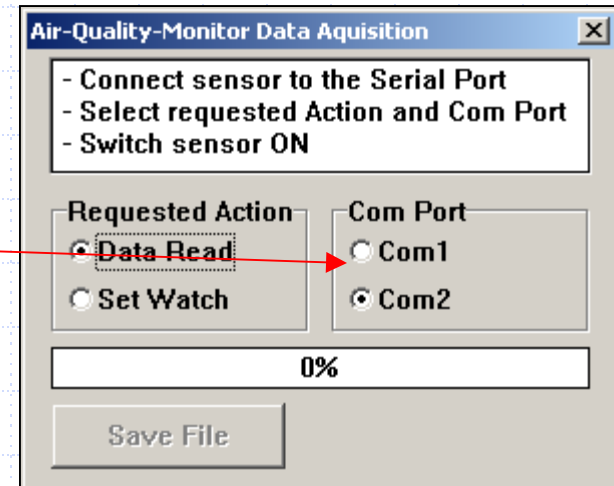
Detailed Download Sequence

1. Put **OFF** the analyzer
2. Connect analyzer to computer with serial cable
3. Start **AIRQUAL** program
4. Select "**Data Read**" as the Requested Action
5. Select correct **COM Port**
6. Switch **ON** the analyzer
7. Wait for the analyzer to start the **download mode**
8. Select the **file to be downloaded**
9. Press the "**Save File**" button to save the file on the computer



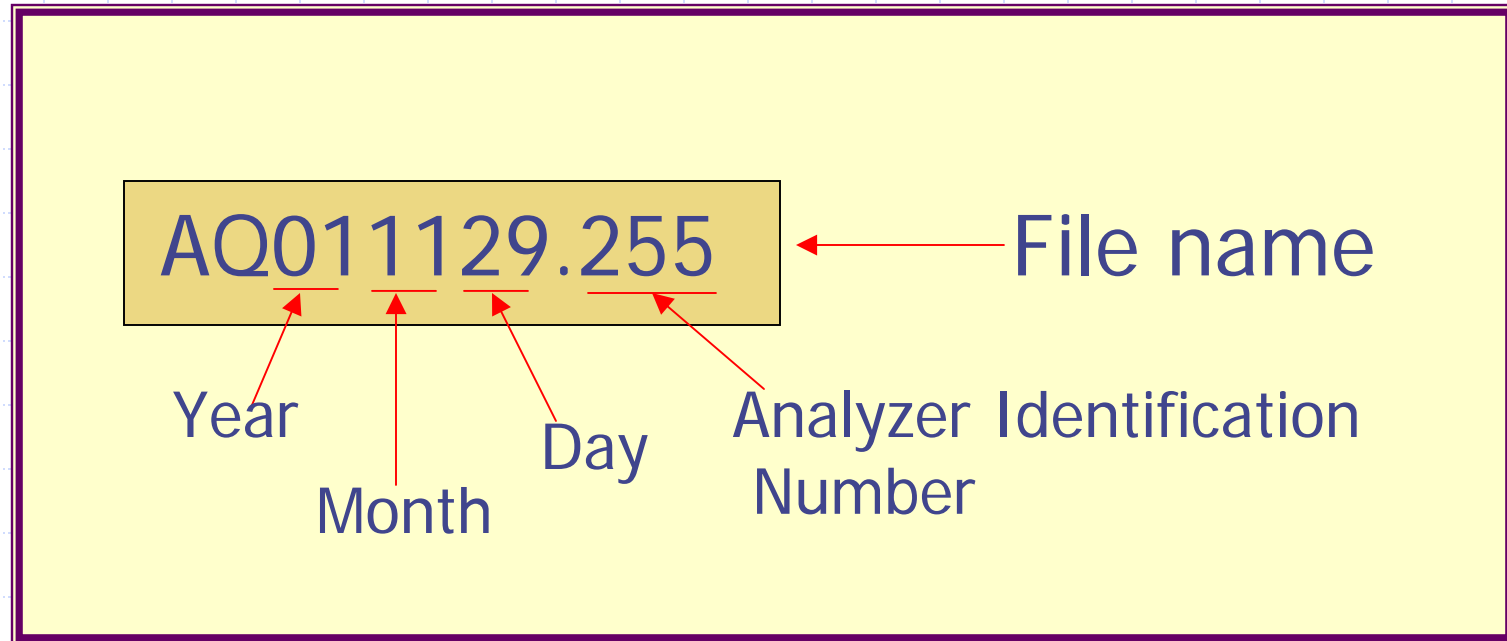
Communication Port

- ◆ Select correct **COM port** (used by RS-232 serial cable)
- ◆ If you have a computer without an RS-232 serial port you need a **USB to Serial port converter** (commonly available at computer stores)



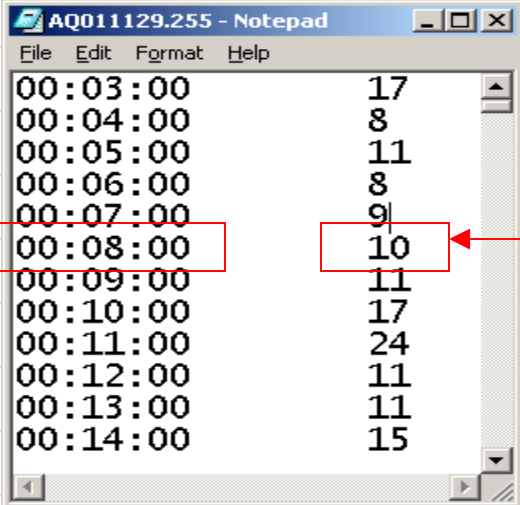
Typical USB/Serial Adapter
Made by Belkin

Data File Name Assignment



Data File Contents

- ◆ Plain text file
- ◆ Time and Value on each line
- ◆ Open with Notepad, Word, Excel etc



The screenshot shows a Notepad window titled "AQ011129.255 - Notepad". The window contains a list of time and value pairs. The time is in HH:MM:SS format, and the value is a number. The data is as follows:

Time	Value
00:03:00	17
00:04:00	8
00:05:00	11
00:06:00	8
00:07:00	9
00:08:00	10
00:09:00	11
00:10:00	17
00:11:00	24
00:12:00	11
00:13:00	11
00:14:00	15

Red arrows point from the labels "Time" and "Value" to the corresponding columns in the table. The row "00:08:00" and its value "10" are highlighted with red boxes.

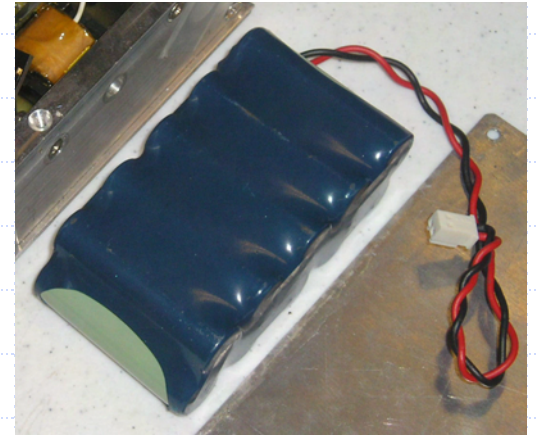
Software Download Troubleshooting Tips

1. Make sure that you are using the **correct serial cable**.
2. The serial cable should be connected to the **right serial port** on the computer (make sure you know whether it is COM1 or COM2).
3. In order to download a file, you have to first select the file by **highlighting** it.
4. Follow the **right sequence** to ensure a smooth download.
5. Once you connect the analyzer and the computer, **power OFF and ON** the analyzer to begin communication



Power for Instruments

1. In the battery-mode the analyzers can be used continuously for **4-6 hours**.
2. When connected to the recharger/power supply unit it can be run continuously without interruption while the battery is being charged at the same time.
3. It takes approximately **8 hours to fully recharge the batteries**. It is not possible to overcharge the batteries, i.e. when they are left on the power supply while the monitor is switched off.



Internal Battery Pack



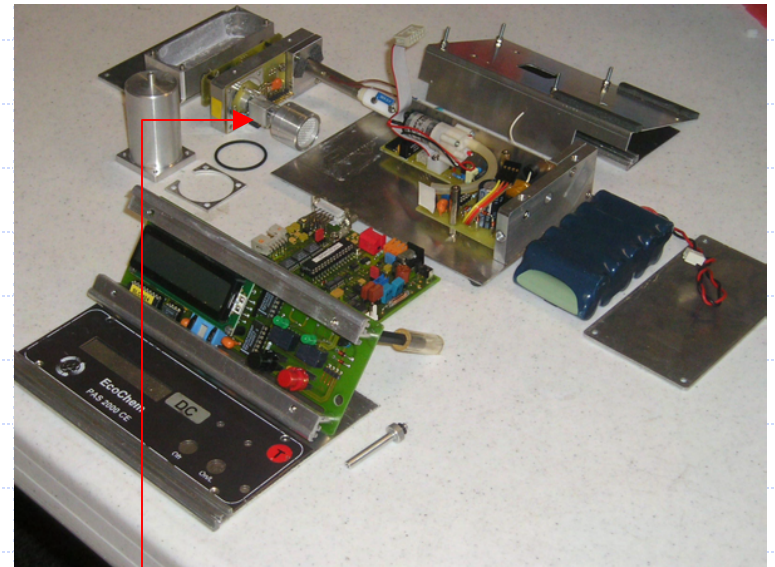
External power supply unit

Service and Maintenance

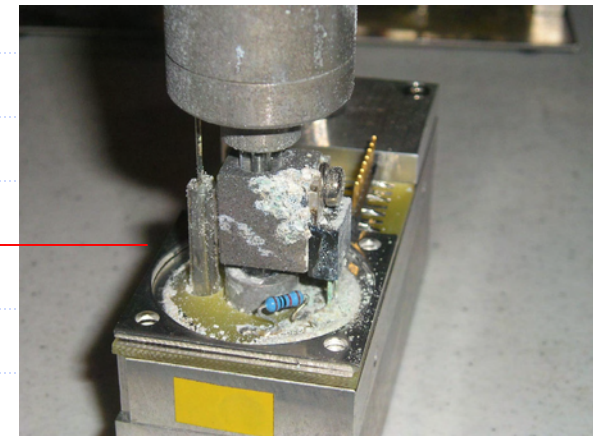


Training and Maintenance Interval

- ◆ Both instruments are sensitive electronic devices and should be serviced only by **appropriately trained personnel**.
- ◆ Depending upon usage of the instruments, it is typically recommended that the instrument be sent back to the factory for service and maintenance **every 12 to 24 months**.



Analyzer components during service



Service needed for an Electrometer

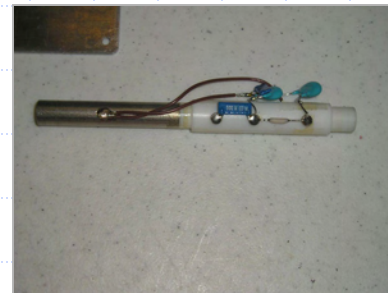
Precision Components



Pump



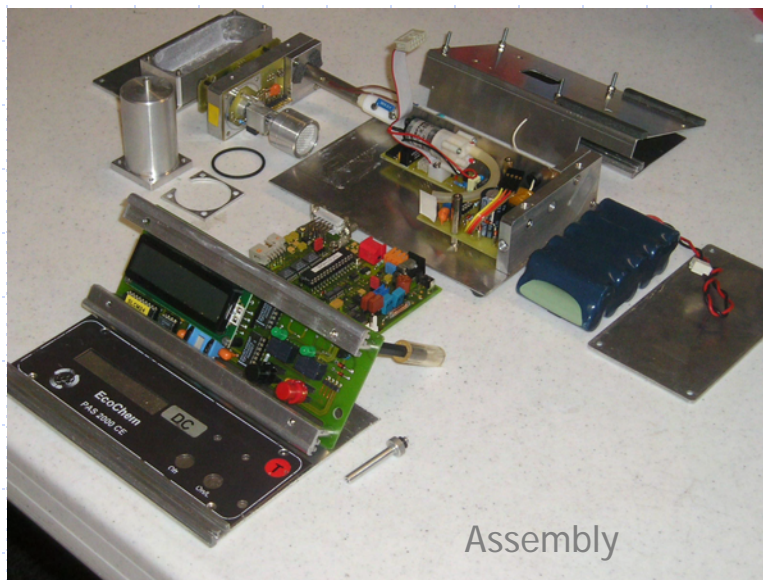
UV Lamp



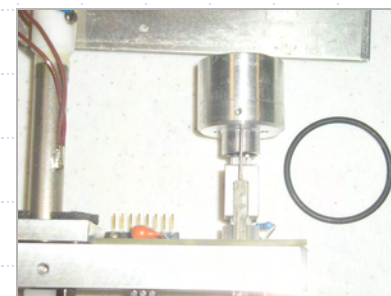
Corona Discharge



Circuit Board



Assembly



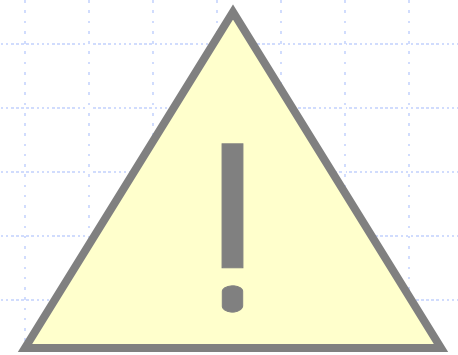
Electrometer

Other Activities...

Call for assistance before doing these activities!

- Software is provided for re-setting the analyzer identification number and the calibration factor
- Sometimes you may have to open the analyzer to disconnect the internal battery or to replace an internal fuse

Call for assistance before doing these activities!



ATTENTION



When in doubt...

- ◆ Refer to the **User's Guide**
- ◆ Contact EcoChem by sending email to **info@ecochem.biz**

User's Guide...

**Photoelectric Aerosol Sensor
(PAS 2000CE)**

**Diffusion Charger
(DC 2000CE)**

EcoChem Analytics

Analyzer Applications

Exploratory study of particle-bound polycyclic aromatic hydrocarbons in different environments of Mexico City

Erik Velasco^{a,*}, Philip Siegmann^b, Hans C. Siegmann^c

^aLaboratory for Atmospheric Research, Department of Civil and Environmental Engineering, Washington State University, Pullman, WA 99164-2910, USA

^bDepartment
^cRece

Fine Particulate Matter and Polycyclic Aromatic Hydrocarbon Concentration Patterns in Roxbury, Massachusetts: A Community-Based GIS Analysis

Jonathan I. Levy,¹ E. Andres Houseman,² John D. Spengler,¹ Penn Loh,³ and Louise Ryan²

¹Department of Environmental Health, Harvard School of Public Health, Boston, Massachusetts, USA; ²Department of Biostatistics, Harvard School of Public Health, Boston, Massachusetts, USA; ³Alternatives for Community and Environment, Roxbury, Massachusetts, USA

Abstract

Given an elevated prevalence of respiratory disease and density of pollution sources, residents of Roxbury, Massachusetts, have been interested in better understanding their exposures to air pollution. To determine whether local transportation sources contribute significantly to exposures, we conducted a community-based pilot investigation to measure concentrations of fine particulate matter (particulate matter < 2.5 μm ; $\text{PM}_{2.5}$) and particle-bound polycyclic aromatic hydrocarbons (PAHs) in Roxbury in the summer of 1999. Community members carried portable monitors on the streets in a 1-mile radius around a large bus terminal to create a geographic information system (GIS) map of concentrations and gathered data on site characteristics that could predict ambient concentrations. Both $\text{PM}_{2.5}$ and PAH concentrations were greater during morning rush hours and on weekdays. In linear mixed-effects regressions controlling for temporal autocorrela-

visibility of the pollution sources. Dudley Square once housed an elevated train station, but this station was converted to a major bus terminal and transportation hub when the train was rerouted and the elevated tracks were removed in the 1980s. A recent survey by Alternatives for Community and Environment (ACE) found that 15 bus and truck depots are located within a 1.5-mile radius of Dudley Square, garaging more than 1,150 diesel vehicles, including approxi-

Example Application Paper

Environ. Sci. Technol. **2004**, *38*, 2584–2592

Vehicle Traffic as a Source of Particulate Polycyclic Aromatic Hydrocarbon Exposure in the Mexico City Metropolitan Area

LINSEY C. MARR, LISA A. GROGAN,
HENRY WÖHRNSCHIMMEL,
LUISA T. MOLINA, AND
MARIO J. MOLINA*

*Department of Earth, Atmospheric, and Planetary Sciences,
Massachusetts Institute of Technology,
Cambridge, Massachusetts 02139*

THOMAS J. SMITH

*Department of Environmental Health, Harvard School of
Public Health, Boston, Massachusetts 02115*

ERIC GARSHICK

*Pulmonary and Critical Care Medicine Section, VA Boston
Healthcare System, Boston, Massachusetts 02132, and
Channing Laboratory, Department of Medicine*

air pollution (1). Due to methodological constraints, the quantification of particulate matter has focused mainly on mass and number properties. However, surface properties of particles may be at least as important as mass in assessing their health effects (2, 3). Surface properties also affect hygroscopicity (4, 5) and heterogeneous chemistry—gas-particle reactions that could alter their chemical composition. New methods allow fast, continuous characterization of aerosol photoemission activity and active surface area using portable, battery-powered instruments. Particulate polycyclic aromatic hydrocarbons (PAHs)—combustion byproducts which include some potent carcinogens and mutagens—can be detected by photoemission induced by exposure to ultraviolet light (6).

The Mexico City metropolitan area (MCMA) is making progress in improving its air quality, but the city's nearly 20 million inhabitants, 3.5 million vehicles, 35000 industries, semitropical latitude, ring of mountains, and 2200 m altitude all contribute to a challenging air quality problem. Ozone levels exceed the health-based standard, which is equivalent to the U.S. standard, on approximately 80% of all days; concentrations of particulate matter of diameter 10 μm and less (PM_{10}) exceed the standard on more than 40% of all days in most years (7). While the literature on particulate matter

Contact info@ecochem.biz for other studies

Example Application Paper (Contd.)

JOEM • Volume 46, Number 9, September 2004

887

FAST TRACK ARTICLE

Respirable Particles and Carcinogens in the Air of Delaware Hospitality Venues Before and After a Smoking Ban

James Repace, MSc

How do the concentrations of indoor air pollutants known to increase risk of respiratory disease, cancer, heart disease, and stroke change after

Secondhand smoke (SHS), ie, indoor air pollution from tobacco combustion, has been condemned as a health hazard by all US occupational health, environmental health, and public health authorities, and smoking has been prohibited in all federal work-

Contact info@ecochem.biz for other studies



THANK YOU

Questions & Answers ?

For more information...



EcoChem Analytics

Email: info@ecochem.biz