Title: Standard Operating Procedure for The Ecochem PAS 2000 analyzer		
Procedure No: SOP-009	Revision No: 0 (new document)	Page No.: 1 of 7

1. INTRODUCTION AND SCOPE

The Ecochem PAS 2000 analyzer is used to obtain continuous real time data for particle-bound PAH for the purpose of air quality assessment or air quality trend reporting. This procedure is specific to the PAS2000 and should not be applied to other PAH analyzers. Ambient air applications for the PAS2000 analyzer include:

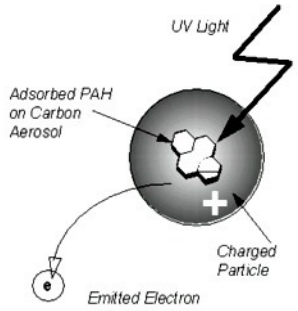
- Outdoor ambient air quality
- Monitoring in special settings eg. parking structures, traffic intersections and motorway tunnels
- Indoor air quality in homes, offices and monitoring indoor sources like kerosene heaters, wood stoves and environmental tobacco smoke
- Workplace monitoring in industrial environments where PAH are produced
- Monitoring PAH generation during special situations eg. Forest Fires, Scrap Vehicle Tire Fires and Agricultural Burns

Information used to write this procedure was taken from sources identified in the reference section.

2. PRINCIPLE OF THE METHOD

The Photoelectric Aerosol Sensor (PAS) works on the principle of photo ionization of particle-bound PAH.

Using an Excimer lamp (KrCl) the sample flow is exposed to UV radiation. The Excimer lamp offers a high intensity, narrow band source of UV radiation. The wavelength of the light (220 nm) is chosen such that only the PAH coated aerosols in the sample flow are ionized, while gas molecules and non-carbon aerosols remain neutral.



The aerosol particles that have PAH molecules adsorbed on the surface emit electrons, which are subsequently removed when an electric field is applied. The remaining positively charged particles are collected on a filter inside an electrometer, where the charge is measured. The resulting electric current establishes a signal, which is proportional to the concentration of total particle-bound PAH. The Excimer lamp is operated in a pulsed mode to eliminate interference from naturally-occurring charged particles present in the sample stream and to suppress zero drift. To

compensate for changes in the Excimer lamp characteristics with time, the intensity of the lamp is monitored and its effective intensity adjusted by varying the frequency.

The analyzer output signal is a measure of total PAH adsorbed on carbon particles and does not speciate the sample.

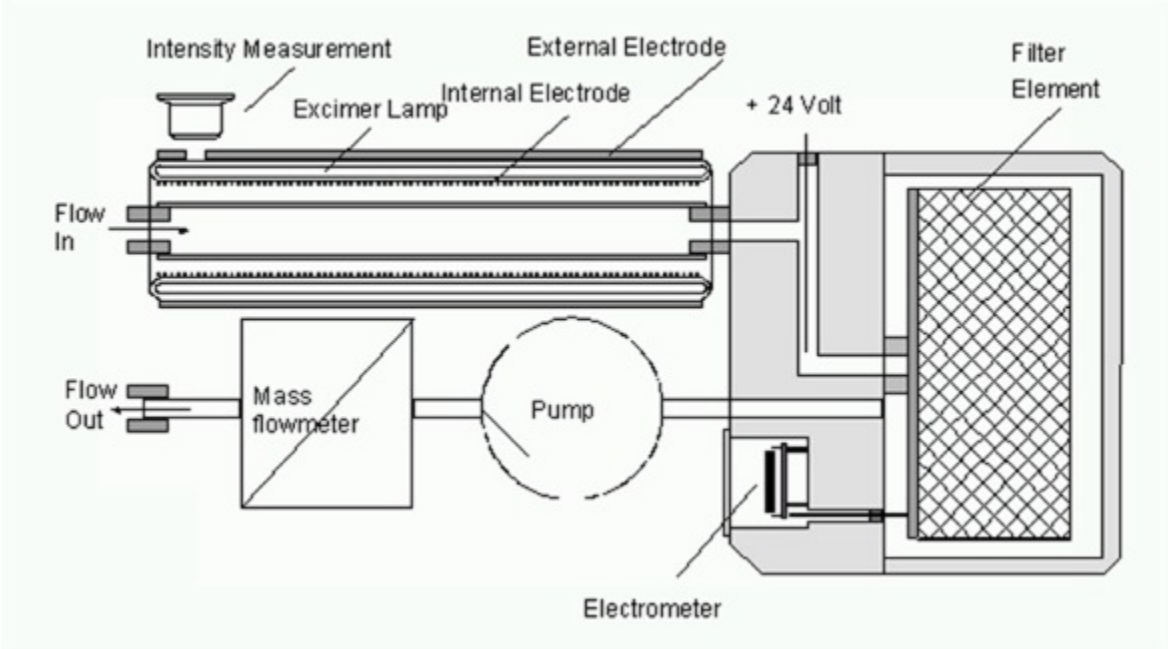


Figure 1 – diagram of the analyzer structure

3. MEASUREMENT RANGE AND SENSITIVITY

The measurement range is user selectable at ranges between 0 to 100 picoamps. This ranged data then utilizes the accompanying software to calculate a real time concentration. Site-specific tests are required to obtain the optimum range for the site.

The detection limit of the PAS 2000 is an ion current of approximately 10 femtoampere (fA). According to the manufacturer, typical response factors are in the range -0.3 to 1 microgram of PAH per cubic meter of gas (at normal conditions) per picoampere (pA). Using these values, one obtains an estimated detection limit of -3 to 10 ng/m3.

4. EQUIPMENT AND APPARATUS

This procedure utilizes the Ecochem Analytics PAS2000 PAH continuous analyzer as the only piece of equipment.

5. INTERFERENCES

Naturally occurring charged particles interfere with the observation of PAH compounds of interest. The lamp is pulsed to obtain a reference to isolate the interfering responses.

6. PRECISION AND ACCURACY

Comparative testing indicated that duplicate PAS 2000 monitors showed the same temporal pattern of ambient PAH levels for both the 15-minute data and 24-hour averages. Regression analysis showed r^2 = 0.989 for the 15-minute data and r^2 = 0.979 for the 24-hour averages. The slopes of the regression lines were 0.779 (0.002) and 0.782 (0.023), respectively, for the 15-minute data and 24-hour averages, indicating a significant bias of about 22% between the two monitors. The intercept of the regression line was -0.66 (0.01) ng/m^3 for the 15minute data, and was -0.68 (0.10) ng/m^3 for the 24-hour data. The calculated coefficient of variation (CV) for the 15-minute data was 60.4%; and, for the 24-hour averages, the CV was 40.8%. Much of these CV values may be attributed to the bias between the monitors and to the fact that the ambient PAH concentrations were comparable to the 3 ng/m^3 nominal detection limit of the monitors, making even small inter-unit differences relatively large contributors to the CV. (ETV, Battelle August 2001)

7. SITE REQUIREMENTS

Site location for ambient PAH monitoring should be determined according to the intended application of the monitoring data. Detailed requirements for selection of sites for monitoring ambient air data can be found in the Station Site Criteria section of the AMD.

8. INSTALLATION REQUIREMENTS

All the installation requirements are specified by the manufacturer in the installation procedures of the manual. General requirements listed below must also be followed. Considerations for sighting requirements can be found in the reference listed in section 7.0 above.

8.1 The ¼ inch outside diameter (inside diameter of 3/16 inch or 1/8 inch) connection tubing from the manifold to the analyzer inlet must be made of Teflon or equivalent material for chemical inertness. Since particles are measured by this method in order to minimize loss of sample due to particles "hanging up" on inlet tube sidewalls or bends keep the line as straight as possible insure the analyzer is as near the manifold as possible.

8.2 A data acquisition system (DAS) should be connected to the analyzer to record or download the signal output from the analyzer. For connection to record analog voltage signals, the system should be set to match the voltage range of the analyzer output. Generally this is 1V or 10V full scale and is scaled to convert the output signal to the concentration range outlined in section 3. See the DAS operations manual for instructions on configuring these channels.

8.3 The monitoring shelter/station temperature should be controlled within the range of 15 to 30°C. It is important to note that the analyzer will operate properly at any temperature within this range; however, the stability of the station temperature is most important.

8.4 Within the vicinity of the station use of all products by the station operator containing solvents and other sources of hydrocarbon must be avoided.

9. OPERATIONAL REQUIREMENTS

The following table provides the basic specifications of the PAS2000 monitor.

Display	LCD Panel with 128 by 64 pixel resolution
Power	115 volts AC / 60 Hz & 220 volts AC / 50 Hz, Max. power consumption 35VA
Range	0 to 100 picoamp (user selectable)

Sensitivity	~ 0.3 - 1 g /m3 PAH per picoamp (actual calibration is site-specific)
Lower Threshold	< 10 seconds (adjustable)
Response time	< 10 seconds (adjustable)
Analog Output	(0 to 10 volt) and (0 to 20 mA or 4 to 20mA)
Digital Output	RS - 232
Sample gas	Built-in pump with flowrate controlled at 2 L/min
Operating temp	5 to 40ºC
Dimensions	Standard Desktop Unit (Height x Width x Depth) 4.5in x 9.3in x 12.5in (133mm x 236mm x 317mm)
Weight	20 lb. (9 kg)
Data Storage	2500 Data Points (each data point consisting of : Date, Time, Value)
Sampling System	The standard PAS 2000 can be modified to include a sample conditioning system. The heated probe can sample source gas temperatures in the range of 40 to 570 ºF (5 to 300ºC). Using a mass-flow controller coupled with a critical orifice, it is possible to obtain dilution ratios of 0.05, 0.1 and 0.2.
Data Acquisition Software	PC-Compatible graphical software collects data from PAS 2000. The software displays real-time strip charts and calculates averages. Data is stored in a variety of formats. Flat ASCII file output can also be generated for further analysis in standard spreadsheet programs (e.g. Microsoft Excel).

All operational activities conducted at any ambient monitoring station, must be documented in the station logbook, and/or station checklists. This allows other operators to access a history of the station if the regular technician is not available. The following documentation must be available to the operators on site: operational and maintenance manual(s), quality system documentation and station site documentation.

10. CALIBRATION

On site calibration of the PAS2000 can be completed but is typically not a feasible means to operate the instrument.
Universal calibration curves are provided by the manufacturer and are implemented on site. See the operations manual for details.

11. APPLICABLE DOCUMENTS

- **EM-009a** Ecochem PAS 2000 operations manual

12. LITERATURE REFERENCES

- S. M. Wall - Improved Methods for PAH Combustion Source Sampling, Report prepared by the California Department of Health Services for the California Air Resources Board, Contract No. A932-098 1996
- Environmental Technology Verification Report - Ecochem PAS2000 PAH Monitor, Battelle, August 2001

13. REVISION HISTORY

Revision 0 (new document)

Reviewed Dec 29, 2011

14. APPROVAL

Approved by: **Harry Benders** **Date:**

Title: **Air Monitoring Team Leader**