ELECTRICAL AEROSOL DETECTOR
MODEL 3070A

A FAST AEROSOL CONCENTRATION DETECTOR FOR WIDE DYNAMIC RANGE

The Electrical Aerosol Detector 3070A (EAD) measures a key aerosol parameter believed to indicate the effective surface area of particles that can be deposited in the lung. This aerosol detector is a unique complement to our line of Condensation Particle Counters (CPCs). Like a CPC, the EAD measures particle concentration as a function of time. But it also measures a parameter called aerosol diameter concentration, a property of ultrafine particles that is promising for health-effects research.

The EAD is a robust, low-cost, easy-to-use instrument that operates continuously and provides very fast measurements in the range from 10 to 1,000 nm. It operates at a wide dynamic range, and it requires no working fluid or consumables. Plus, the EAD gives you unmatched reproducibility.

Applications

+ Ambient aerosol monitoring
+ Combustion-generated particle studies
+ Epidemiological studies of human health effects
+ Inhalation and exposure studies

Features and Benefits

+ Measures particles from 10 to 1,000 nm
+ Provides unmatched reproducibility
+ Designed for continuous, unattended operation
+ Requires no working fluid or consumables

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Features

The EAD is a unique instrument that offers a number of exciting features:

+ Submicrometer particle measurements – in the range from 10 nanometers to greater than 1 micrometer.

+ High time resolution – maximum data rate of 3.75 readings per second allows the EAD to detect fast-changing events and study aerosol dynamics.

+ Mean diameter of aerosol (when combined with a CPC) – calculated using the diameter concentration measured by the EAD divided by the number concentration from the CPC

$$D_{Mean} = (EAD_{diameter}/CPC_{number})$$

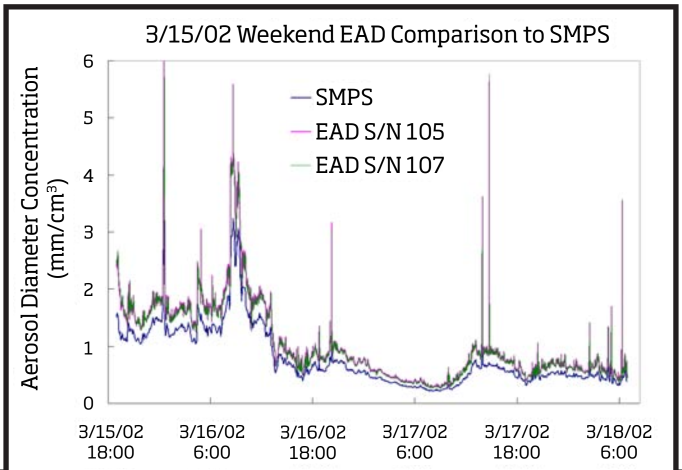
+ Wide dynamic range – measures over 5 decades of concentration range (0.01 to 2500 mm/cm^3) without the need for coincidence correction or aerosol dilution.

+ Robustness and ease-of-use – both characteristics are critical for continuous, routine measurements.

+ No working fluid – allows easy transport and eliminates the need to drain a reservoir.

+ No consumables – translates to a low cost of operation.

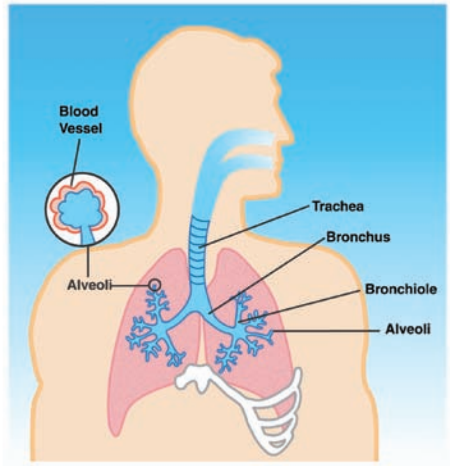
+ Unmatched reproducibility – readings of two co-located EADs during a six-month field trial were within ±1 percent (see figure below).



Readings from two co-located EADs during a six-month field trial. The green and magenta lines for the two EADs overlap each other. The blue line is the diameter concentration calculated from a Scanning Mobility Particle Sizer™ (SMPS™) spectrometer measuring at the same site. The EAD readings are higher than the SMPS readings because the EADs cover a broader size range.

Applications

The EAD is well-suited for ambient aerosol monitoring, combustion-generated particle studies, and particularly, epidemiological studies of human health effects (W.E. Wilson et al., 2004). In fact, continuous measurements of aerosol diameter concentration with the EAD correlate well with the surface area of particles deposited in the tracheobronchial and alveolar regions (see figure).
EAD measurements are also thought to provide a better estimate of surface area deposition in the lung than the mass or number concentration of particles.



Unique Information

The aerosol diameter concentration as measured by the EAD offers new insights into the health effects of particles. The aerosol diameter concentration (in mm/cm^3), also called total aerosol length (d^1), is defined as the length of a chain with all particles from 1 cm^3 of measured aerosol lined up on the chain. Hence, the EAD measurement falls between number concentration (d^0) and surface area (d^2).

d^0	d^1	d^2	d^3
number concentration (particles/cm^3)	number concentration (mm/cm^3)	number concentration ($\mu m/cm^3$)	number concentration ($\mu m/cm^3$)

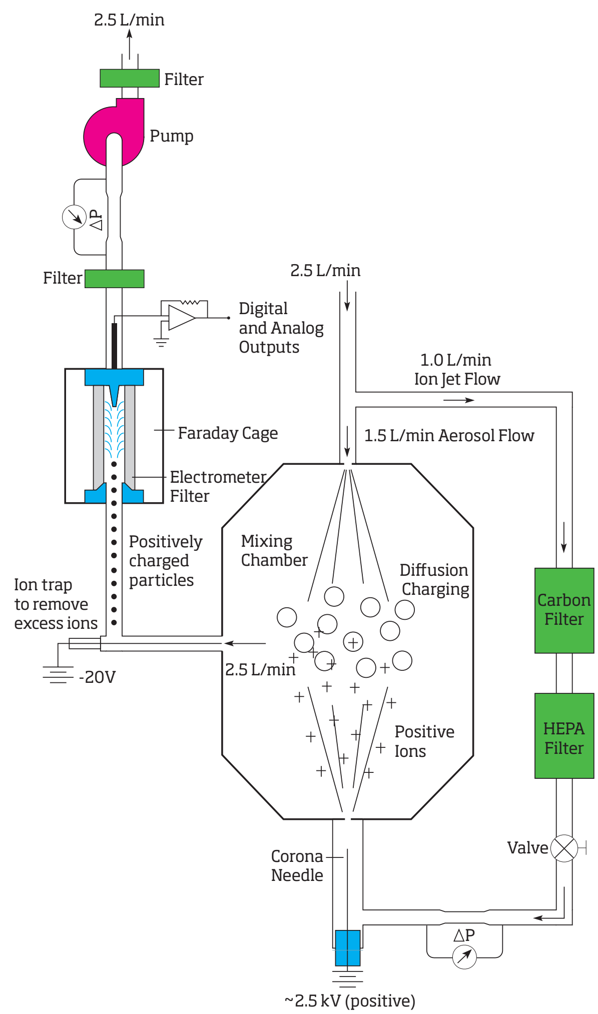
Operation

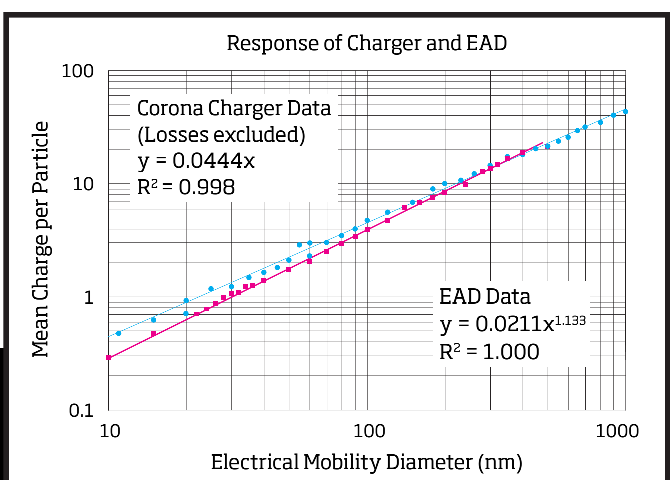
The operating principle of the TSI Model 3070A EAD is based on diffusion charging of particles, followed by detection of the aerosol via a sensitive electrometer. Aerosol enters the instrument at 2.5 liters per minute. The flow is split, with 1 liter per minute passing through a filter and ionizer, and the remaining 1.5 liters per minute making up the aerosol flow.

The flows reunite in a mixing chamber where particles in the aerosol flow mix with the ions carried by the filtered clean air. This "counter-flow diffusion charging" brings the aerosol particles into a defined charge state. The separation of the particles from direct interaction with the corona needle and/or the strong field near it reduces particle losses and makes the charging process more efficient and reproducible. The charged aerosol then passes through an ion trap to remove excess ions and moves on to a highly sensitive aerosol electrometer for charge measurement.

The patented* diffusion charger produces a linear relationship between particle diameter and the number of elementary units of charge acquired for particles in the range from 10 nanometers to 1 micrometer (Kaufman S.L. et al., 2002). The overall EAD response that includes internal particle losses follows a nearly linear power law, with the net electrometer current being proportional to the 1.133 power of the particle diameter (see figure below). Data from the EAD is displayed in real time on the instrument LCD panel.

*US Patent No. 6,544,484





SPECIFICATIONS

ELECTRICAL AEROSOL DETECTOR MODEL 3070A

Size Range
10 nm to >1 µm

Measurement Range

Diameter Concentration	0.01 to 2500 mm/cm³ (corresponds to 2 × 10² to 5 × 10⁷ particles/cm³ in number concentration for monodisperse 50 nm particles)
Current	0.002 to 400 pA

Maximum Data Rate
3.75 readings/sec

Data Resolution
1 fA or 0.01 mm/cm³

Flow Rates

Aerosol	1.5 L/min
Charger	1.0 L/min
Total	2.5 L/min

Front-panel Display
5-character segmented LCD

Operating Temperature
10 to 40°C

Communications
9-pin RS-232

Outputs

Configurable Analog	BNC (0 to 10V)
Digital I/O	9-pin RS-232

Dimensions

Aerosol Inlet	6.4 cm (1/4-in.) OD
Overall (L x W x H)	38 cm × 28 cm × 13.3 cm (15 in. × 11 in. × 5.3 in.)

Weight
6.7 kg (14.8 lb)

TO ORDER
Condensation Particle Counter

Specify	Description
3070A	Electrical Aerosol Detector

Bibliography

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