

Model 3070A Electrical Aerosol Detector

*A fast aerosol concentration detector
for wide dynamic range*

The Model 3070A Electrical Aerosol Detector (EAD) is a novel particle instrument that complements TSI's family of Condensation Particle Counters (CPCs). It is a robust, low-cost, easy-to-use instrument that operates continuously and provides very fast measurements. Like a CPC, the EAD measures particle concentration as a function of time. It differs in that it measures a parameter called aerosol diameter concentration, a property of ultrafine aerosol particles that is promising for correlating with their adverse health effects.

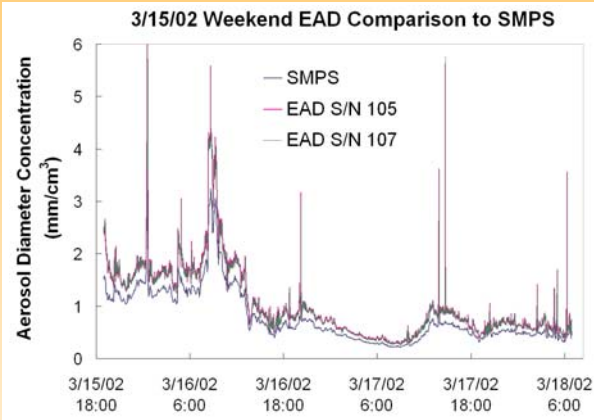
The EAD is a unique instrument that offers a number of exciting features:

- **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

$$D_{\text{Mean}} = (\text{EAD}_{\text{diameter}} / \text{CPC}_{\text{number}})$$



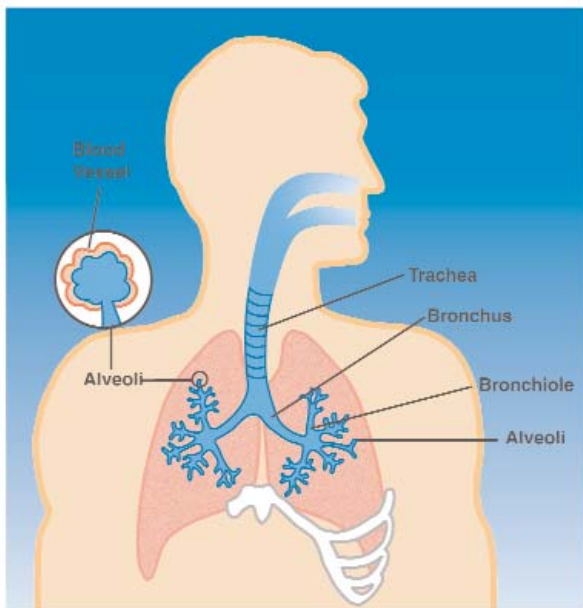
- **Wide dynamic range** – measures over 5 decades of concentration range (0.01 to 2500 mm/cm³) without the need for coincidence correction or aerosol dilution
- **Robustness and ease-of-use** – both characteristics are critical for continuous, routine measurements
- **No working fluid** – allows easy 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 on next page)



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.

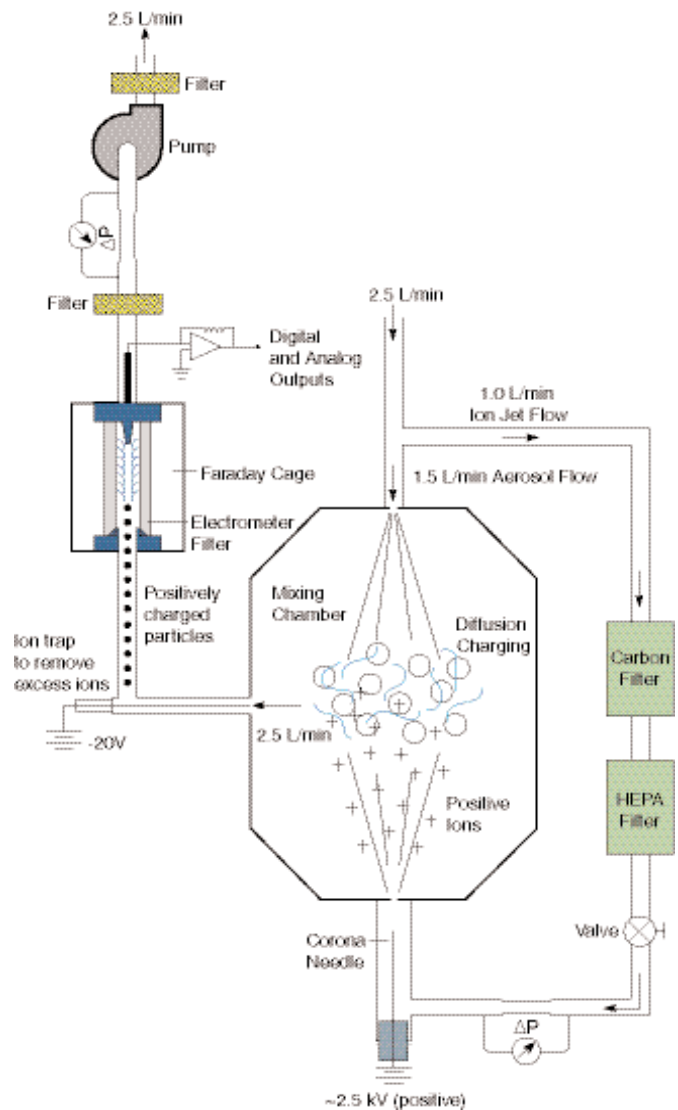
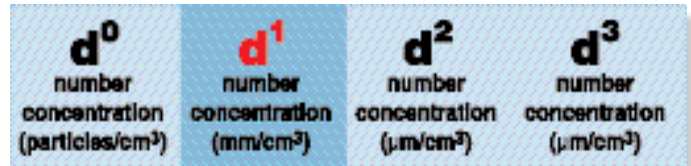
Applications

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). 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 thought to provide a better estimate of surface area deposition in the lung than the mass or number concentration of particles. Contact your TSI representative for additional information regarding applications.



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).



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.

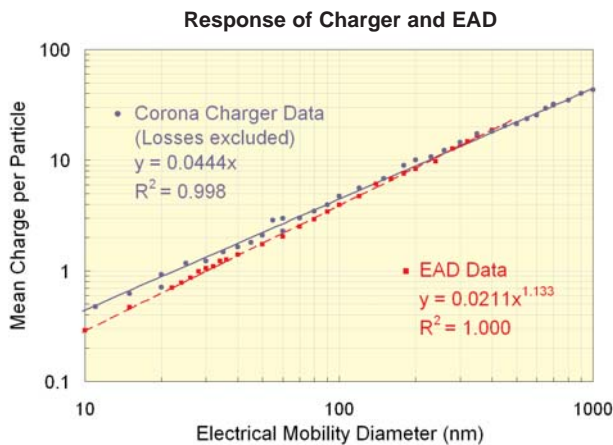
*US Patent No. 6,544,484

Specifications

Model 3070A Electrical Aerosol Detector

Size Range	10 nm to >1 μm
Measurement Range	
Diameter Concentration	0.01 to 2500 mm/cm^3 (corresponds to 2×10^2 to 5×10^7 particles/ cm^3 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/cm^3
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 (LWH)	38 cm \times 28 cm \times 13.3 cm (15 in. \times 11 in. \times 5.3 in.)
Weight	6.7 kg (14.8 lb)

Specifications subject to change without notice.



To Order

Specify	Description
3070A	Electrical Aerosol Detector

Bibliography

Kaufman S.L. *et al.*, “An Electrical Aerosol Detector Based on the Corona-Jet Charger,” *Poster P12-07, Abstracts of 2002 AAAR, Charlotte, NC*, p. 223 (2002).

Lawless P.A., “Particle Charging Bounds, Symmetry Relations, and an Analytic Charging Rate Model for the Continuum Regime,” *J. Aerosol Sci.* **27**:191-215 (1996).

Medved A. *et al.*, “A New Corona-based Charger for Aerosol Particles,” *J. Aerosol Sci.* **31**:S616-S617 (2000).

Wilson W.E. *et al.*, “Use of the Electrical Aerosol Detector as an Indicator for the Total Particle Surface Area Deposited in the Lung,” *Proceedings of 2004 A&WMA, paper #37* (2004).

Woo K.S. *et al.*, “Use of Continuous Measurements of Integral Aerosol Parameters to Estimate Particle Surface Area,” *Aerosol Sci. Technol.* **34**:57-65, (2001).



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