



PARTICLE INSTRUMENTS

Particle Catalog



TRUST. SCIENCE. INNOVATION.

TSI Particle Technology

A leading developer of aerosol research instrumentation since 1966, TSI® Incorporated offers a line of particle instruments that is second to none. Our products for sizing, counting, characterizing, generating, and dispersing aerosol particles are well known—and well respected—all over the world. We are dedicated to providing our customers with the most innovative particle technology available.

This catalog contains many proven instruments as well as our newest product offerings. The scope of this product line shows how TSI leads when it comes to performance and depth. Our intent is to offer a TSI instrument to handle most every particle research need. So browse through the following pages. Then let us know how we can help you achieve your research goals.



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Ford Research Center Aachen



Dr. Risto Hillamo

TSI particle instruments are used all over the world in a variety of important aerosol research applications. We have been making reliable instrumentation for this specialized area of research for more than 40 years.



Applications

Collectively, our line of particle instruments spans the size range from 0.002 to 2000 micrometers. This unique and comprehensive family of products is used all over the world in a variety of interesting applications:

- Basic aerosol research
- Environmental studies
- Bio-aerosol detection
- Pharmaceutical research
- Health effects studies
- Inhalation toxicology
- Filter testing
- Instrument calibration and standards
- Indoor-air-quality testing
- Industrial hygiene research
- Nanotechnology research
- Energy and combustion studies
- Diesel- and gasoline-engine emissions measurements
- Climate change research
- Particle formation and growth studies

Ask your TSI representative for information about specific applications, instrument operation, specifications, or new instruments not included in this catalog. To request additional literature or to place an order, call:

US & Canada: 1-800-874-2811

Europe: +49 241 523030

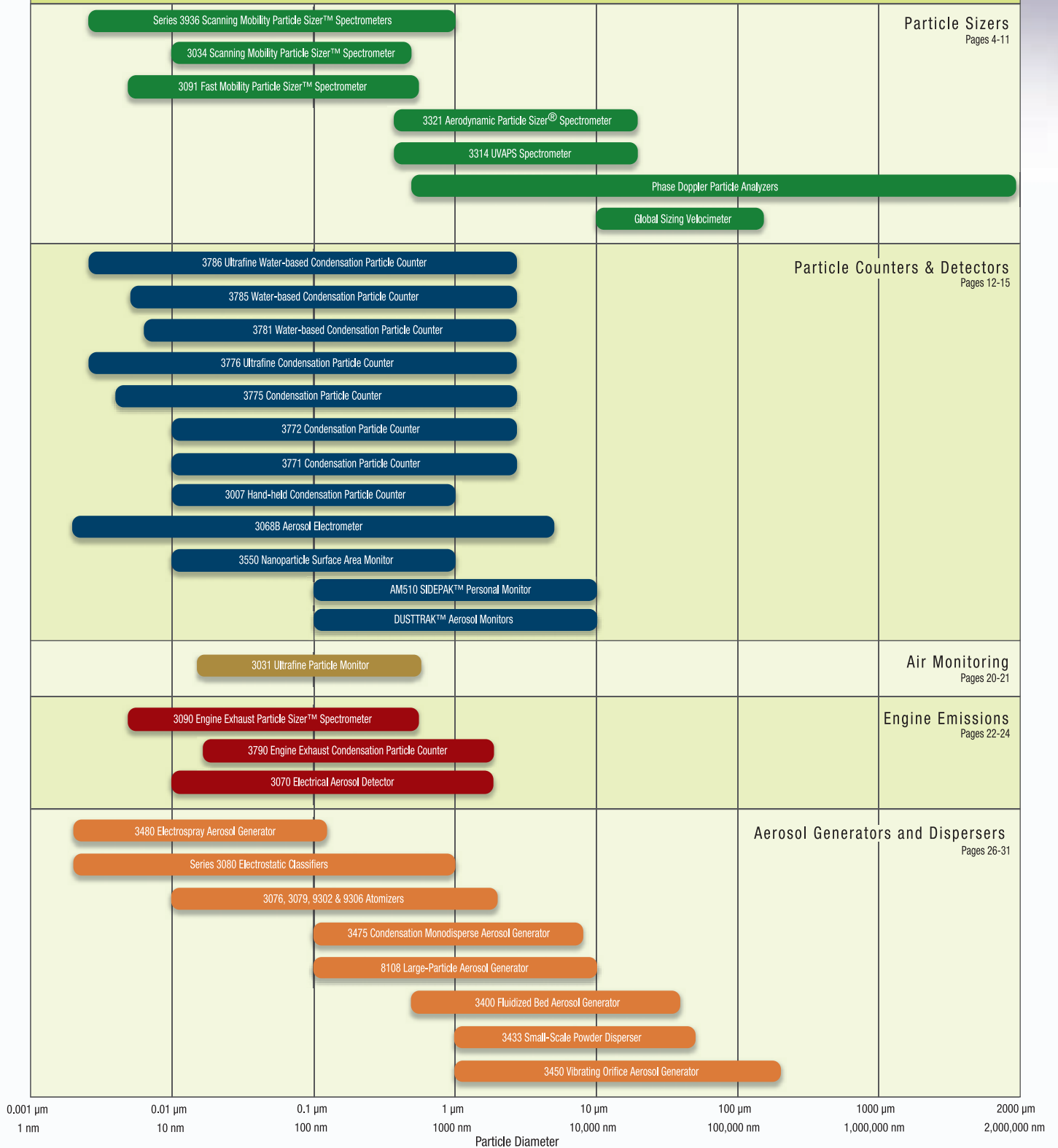
Additional contact information appears on the back cover. Visit our web site for the most current product information available:

www.tsi.com
particle.tsi.com
www.tsiinc.de
www.tsiinc.fr



Dr. Lidia Morawska

Operational Ranges for TSI Particle Instruments





Particle Sizers



3936N86

The most comprehensive selection of instruments for sizing submicrometer and supermicrometer particles.

Sizer	Model	Particle size range (µm)	Particle concentration (#/cm ³)	Measurement time (sec)	Resolution (total channels measured)	Channels per decade	Key feature	DMA	CPC	Condensing liquid		
SMPS	3936L72	0.01 to 1.0	1 to 10 ⁷	30 to 600 (selectable)	Varies by model, 167 channels from 0.0025 to 1.0 µm, collectively	4, 8, 16, 32, 64 (selectable)	Highest-resolution; individual components provide greatest flexibility	3081	3772	n-butyl alcohol		
	3936L75	0.01 to 1.0	2 to 10 ⁸								3085	3775
	3936N75	0.004 to 0.15									3081 & 3085	3081
	3936L76	0.01 to 1.0	10 to 10 ⁷					3085	3776			
	3936N76	0.0025 to 0.15						3081 & 3085	3081			
	3936NL76	0.0025 to 1.0	1 to 10 ⁸					3085	3785			
	3936L85	0.01 to 1.0						3081 & 3085	3081			
	3936N85	0.005 to 0.15	2 to 10 ⁷					3081 & 3085	3786			
	3936NL85	0.005 to 1.0						3081	3786			
	3936L86	0.01 to 1.0	2 to 10 ⁷					3081 & 3085	3786			
	3936N86	0.0025 to 0.15						3081	3786			
	3936NL86	0.0025 to 1.0	3081 & 3085					3786				
		3034	0.01 to 0.487					1 to 2.4x10 ⁶	180		54	32
FMPS	3091	0.0056 to 0.56	Varies by size*	1	32	16	Fast distributions					
APS	3321	.37 to 20	0.001 to 10 ⁴	1 sec to 18 (variable)	52	32	Aerodynamic size	n/a	n/a	n/a		
UVAPS	3314		0.001 to 300				52 [‡]				Size and fluorescence	

n/a = not applicable, *FMPS: 100 to 10⁷ at 5.6 nm, 1 to 10⁵ at 560 nm (1-sec average) †Optical detection down to 0.37 µm; aerodynamic sizing down to 0.5 µm ‡Up to 52 channels of aerodynamic size, up to 64 channels of fluorescence intensity, up to 16 channels of scattered-light intensity

Scanning Mobility Particle Sizer™ Spectrometers Model 3936

Our most versatile submicrometer particle sizers provide the highest resolution and accuracy available.

Collectively, our Series 3936 Scanning Mobility Particle Sizer (SMPS™) spectrometers measure particles from 0.0025 to 1.0 µm. They display data using up to 167 actual size channels (up to 64 channels per decade). A continuous, fast-scanning measurement technique eliminates gaps in particle-size-distribution data and allows measurements to be completed in as few as 30 seconds. SMPS spectrometers are capable of measuring a very wide concentration range, from 1 to 10⁸ particles/cm³.

Component SMPS systems feature the Model 3080 Electrostatic Classifier with your choice of Differential Mobility Analyzer (DMA), and a large selection of Condensation Particle Counters (CPCs). The versatility afforded by individual components enables you to select a system that best fits your sizing requirements. All components can be operated as stand-alone instruments for experiments involving monodisperse aerosol generation or counting the total number of particles.

SMPS spectrometers provide additional flexibility by allowing you to adjust the sample flow rate (from 0.2 to 2.0 L/min). This effectively enables you to select the particle size range of interest. The Electrostatic Classifier has temperature- and pressure-corrected flow rates for measurements made at elevations other than sea level. The end result is an unmatched, proven solution for research involving combustion, atmospheric aerosols, indoor air quality, filter testing, and much more.

Our Aerosol Instrument Manager® software controls instrument operation and provides impressive file-management capabilities. Data can be weighted by number, surface, volume, or mass. An export function allows easy transport of files to spreadsheet or other applications for customized data handling. Additional software capabilities include multiple-scan averaging, a buffer for comparing data sets, multiple-charge correction for up to 10 charges, programmable start/stop times, automatic file storage and printout options, and impactor- and CPC-efficiency correction factors.

SMPS Accessories (available separately)

- 379020 Rotating Disk Thermodiluter (below and page 24)
- 390069 Data Merge Software (below)
- 3089 Nanometer Aerosol Sampler (page 32)
- 3065 Thermodenuder (page 34)

See pages 12, 13, 27, and 33 for information on individual SMPS system components.

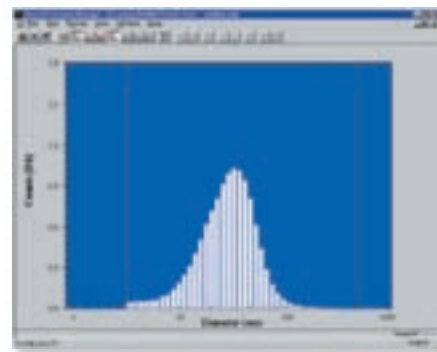
Upgrade your older SMPS system!

Customers with Series 3934 SMPS spectrometers can upgrade to a Series 3936 system. Keep the CPC, pre-impactor, and Aerosol Neutralizer, then let us modify your old DMA for use on a Model 3080 platform! Purchase of the Series 3936 software upgrade is required. Call your TSI representative for additional requirements.

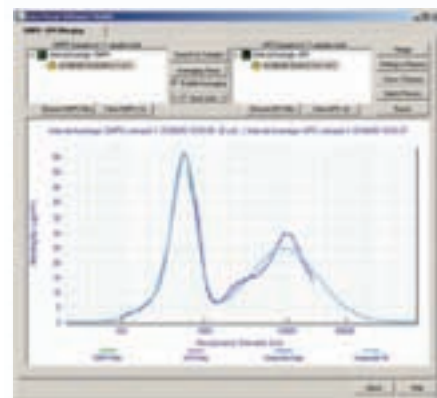
Thermodiluter and Data Merge Software

The Rotating Disk Thermodiluters complement TSI particle sizers and counters when used for particle emission measurement, especially when sampling, diluting, and conditioning exhaust particles from diesel and spark-ignition engines. See page 24 for a description of the thermodiluters and accessories.

The Model 390069 Data Merge Software module works with our Aerosol Instrument Manager software and simplifies the tedious task of merging SMPS and Aerodynamic Particle Sizer® (APS™) data files. Data sets can be averaged, merged, and fitted to multimodal distributions, and graphs and tables can be generated easily.



SMPS component systems give you the highest-resolution particle size data.

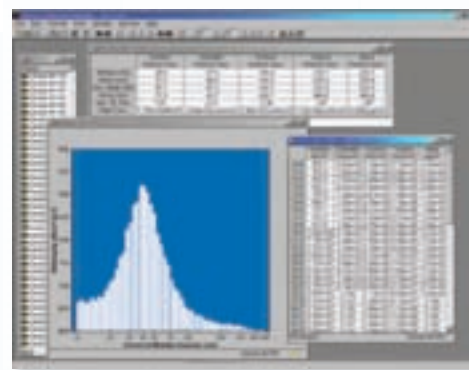
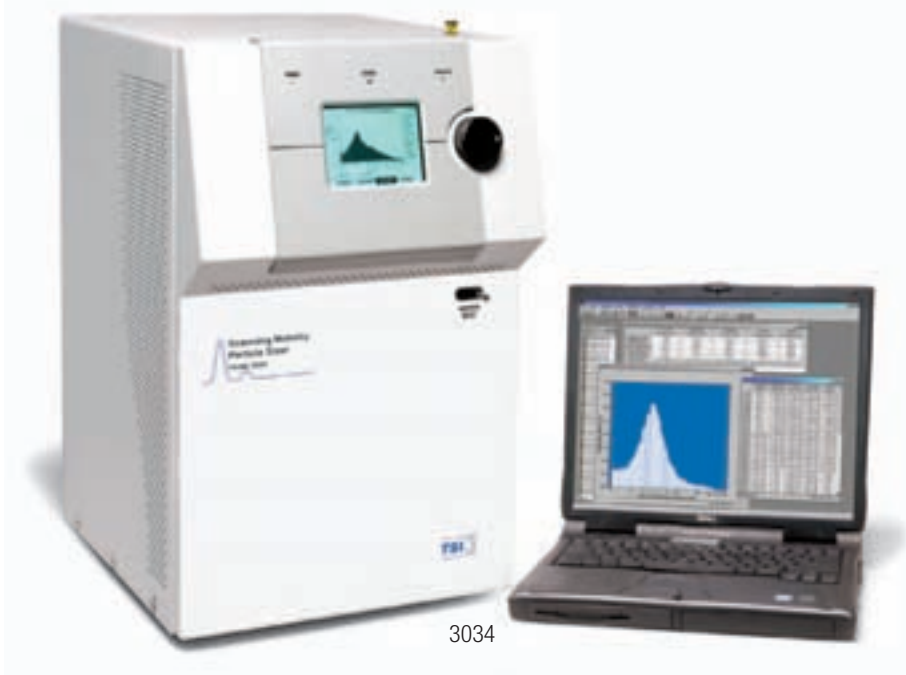


Model 390069 Data Merge Software allows you to merge and fit SMPS and APS data files to create and display a wide particle size range.

See the single-box SMPS spectrometer on the following page!



Scanning Mobility Particle Sizer™ Spectrometer Model 3034



Get high-resolution measurements from our easy-to-use, single-box SMPS spectrometer.

Component SMPS spectrometers are described on the previous page.

An easy-to-use, submicrometer particle sizer for a wide range of industrial measurements or continuous environmental monitoring.

The single-box Model 3034 Scanning Mobility Particle Sizer (SMPS™) spectrometer is ideal for industrial research applications such as steady-state particle emissions testing, indoor-air-quality measurements, or inhalation research involving the health effects of ultrafine particles. The Model 3034 is also designed for continuous, environmental monitoring without operator intervention. It can operate for 30 days without a refill, it includes an auto-recovery feature in the event of a power loss, and it uses only 1 Kb of PC memory per scan! Plus, the Model 3034 corrects for ambient pressure and temperature automatically, so there is no need for post-acquisition data manipulation. It includes TSI's Aerosol Instrument Manager® software for data acquisition and analysis.

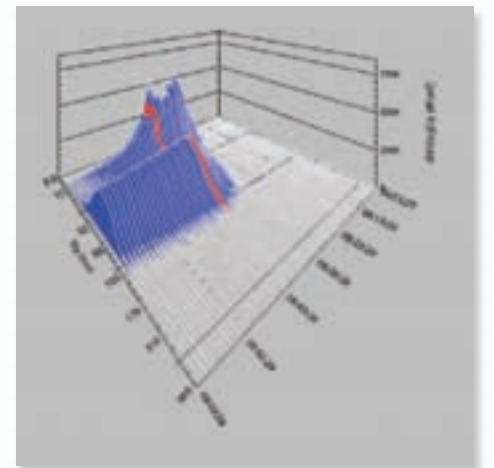
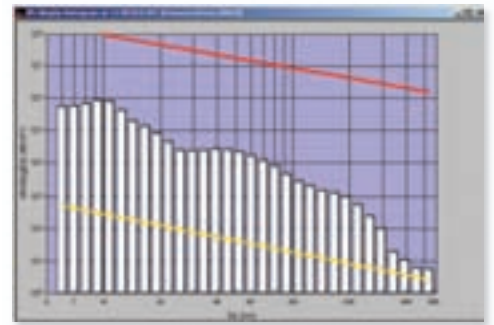
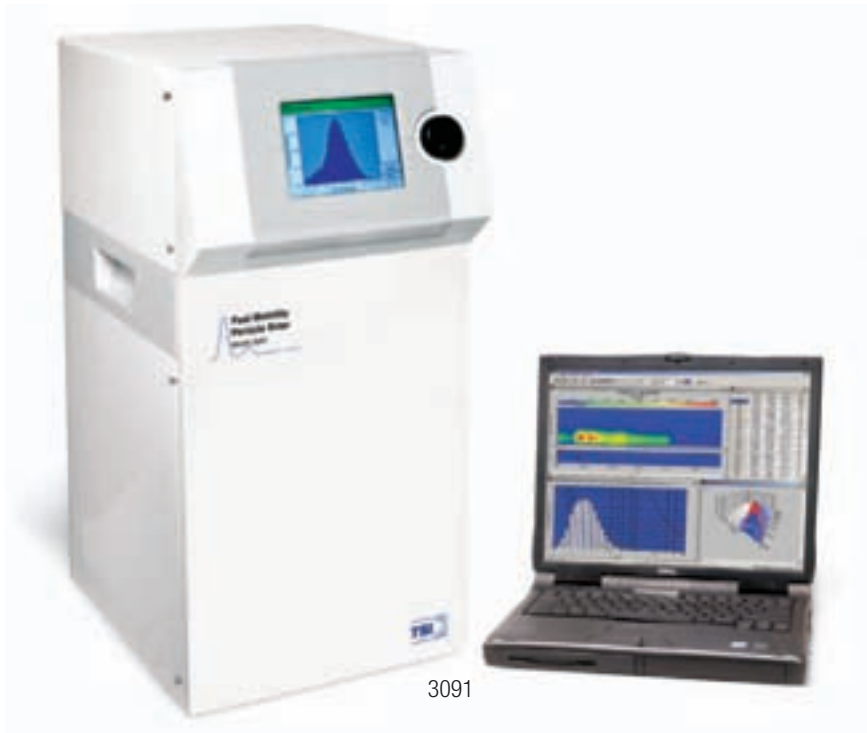
Like our component SMPS spectrometers, the Model 3034 uses a continuous, fast-scanning technique to avoid gaps in the particle-size-distribution data. In addition, the Model 3034 has a Condensation Particle Counter and Differential Mobility Analyzer integrated in a single cabinet. All flow controls and operating parameters are set automatically. This greatly simplifies instrument transport, set up, and operation, and it eliminates the need for an aerosol specialist to run the instrument. In terms of simplicity, the Model 3034 SMPS operates much like our easy-to-use Model 3321 Aerodynamic Particle Sizer® spectrometer, but for measurements in the submicrometer range.

SMPS Accessories (available separately)

379020 Rotating Disk Thermodiluter (page 24)

390069 Data Merge Software (page 5 and 8)

Fast Mobility Particle Sizer™ Spectrometer Model 3091



Measures size distribution and number concentration of rapidly changing, submicrometer aerosol particles in real time.

The Fast Mobility Particle Sizer (FMPS™) spectrometer measures particles in the range from 5.6 to 560 nm, offering a total of 32 channels of resolution (16 channels per decade). This submicrometer particle sizer uses an electrical mobility measurement technique similar to that used in the SMPS spectrometers. However, instead of a CPC, the Model 3091 FMPS spectrometer makes use of multiple, low-noise electrometers for particle detection. This produces particle-size-distribution measurements with one-second resolution, providing the ability to visualize particle events and changes in particle size distribution in real time.

The Model 3091 operates at a high flow rate (10 L/min) to minimize diffusion losses of ultrafine and nanoparticles. It operates at ambient pressure to prevent evaporation of volatile and semivolatile particles. It requires no consumables. Plus, it uses an efficient, unipolar charger to eliminate the need for a radioactive neutralizer.

FMPS software enables you to view a variety of parameters. Here, the same data are pictured in a bimodal concentration histogram and a 3-D size distribution vs. time.

The FMPS is easy to transport, set up, and operate. It can be configured to measure single or multiple runs continuously for up to 12 hours in length. Its large, color VGA display and built-in control knob provide easy access to instrument functions, set-up menus, and data displays. Software highlights include a variety of graphing options, including 3-D playback of size distribution and concentration versus time, data export capabilities, and the ability to input individual effective densities per channel to calculate a continuous output of total particulate mass.

All of these features make the FMPS spectrometer appropriate for a variety of applications, especially particle formation and growth studies, indoor-air-quality measurements, environmental research, inhalation toxicology studies, urban canyon studies, and transient emission studies from stacks, boilers, and wood burners.

Developed by TSI Incorporated under license from Airel, Ltd. of Tartu, Estonia.
U.S. Patent No. 7,230,431



Aerodynamic Particle Sizer® Spectrometer Model 3321



The only way to determine a particle's true airborne behavior is to measure its aerodynamic diameter.

Aerodynamic measurements account for differences in particle size, shape, and density. This is crucial when determining if a particle will penetrate a filter, be removed by a cyclone, or be deposited in the lung.

The Aerodynamic Particle Sizer (APS™) spectrometer has been used successfully for over 20 years in laboratory and field applications. It provides high-resolution, real-time aerodynamic measurements in the range from 0.5 to 20 µm. Our latest models also measure light-scattering intensity in the equivalent optical size range of 0.37 to 20 µm. By providing paired data for each particle, the APS opens up exciting new possibilities for aerosol scientists interested in studying the makeup of an aerosol.

The Model 3321 APS spectrometer uses a patented, double-crest optical system for unmatched sizing accuracy. It also includes a redesigned nozzle configuration and improved signal processing. The result is greater small-particle sizing efficiency, improved accuracy of mass-weighted distributions, and virtual elimination of false background counts. The Aerosol Instrument Manager® software provides advanced data-handling capabilities.

APS Accessories (available separately)

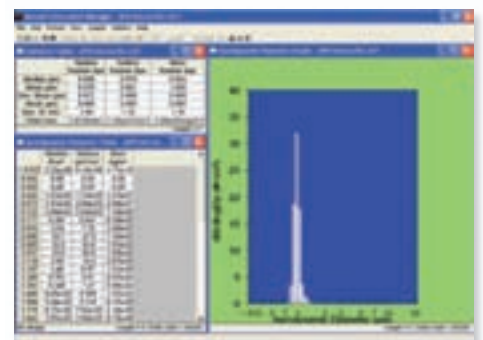
- 3302A Aerosol Diluter (page 9)
- 3306 Impactor Inlet (page 9)
- 3433 Small-Scale Powder Dispenser (page 29)
- 390069 Data Merge Software (below)

Upgrade your Model 3320

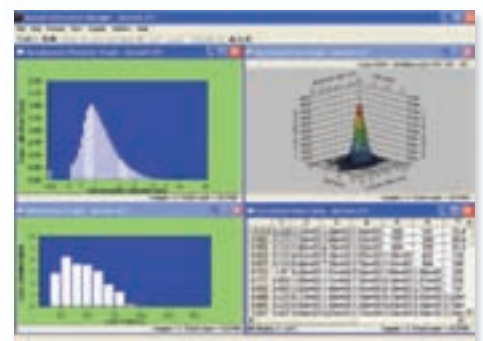
Model 3320 APS spectrometers may be upgraded to a Model 3321. Contact your TSI representative for specific information.

Data Merge Software

The Model 390069 Data Merge Software module works with our Aerosol Instrument Manager software and simplifies the tedious task of merging Scanning Mobility Particle Sizer™ (SMPS™) and APS data files. Data sets can be averaged, merged, and fitted to multimodal distributions, and graphs and tables can be generated easily.



APS software has advanced instrument-control and data-handling features. Above, a graph of aerodynamic diameter is displayed with particle-size and statistics tables.



Three graphs showing aerodynamic diameter, side scatter, and correlated data are displayed on this screen simultaneously.

United States Patent Number 5,561,515

Aerosol Diluter Model 3302A



3302A
(APS sold separately)

Conditions high-concentration aerosols for use with the APS spectrometer.

This diluter reduces particle concentrations of high-concentration aerosols, providing a representative sample that meets the input requirements of the Aerodynamic Particle Sizer® (APS™) spectrometer (page 8). The 3302A achieves dilution ratios of 100:1 and 20:1 using easy-to-change capillary tubes. Two diluters in a tandem configuration provide dilution ratios as high as 10,000:1.

Engineered to provide very low particle loss in the 0.5- to 10- μ m size range, the Aerosol Diluter is totally self-contained and requires no outside power or compressed gas. Durable construction and simple maintenance procedures translate into years of trouble-free operation. Model 3302A works with both old and new APS spectrometers.

Impactor Inlet Model 3306



3306
(APS sold separately)

Collects a size-segregated sample for mass or chemical analysis while making APS measurements.

An accessory for our Aerodynamic Particle Sizer spectrometer (page 8), the 3306 combines a single-stage impactor with a filter. It takes a size-segregated sample and directs a diluted (80:1), representative portion of the initial test aerosol into the particle sizer for measurement. The inlet aerosol passes through a single-stage impactor (2.5 or 4.7 μ m, 50% cut size) and is collected with an after-filter for later mass or chemical analysis. Model 3306 includes two inlet throats: one for standard applications; the other for pharmaceutical research.

Accessory (available separately)

3033 Vacuum Pump (page 35)



Ultraviolet Aerodynamic Particle Sizer® Spectrometer Model 3314



An instrument for characterizing biological and other fluorescing particles.

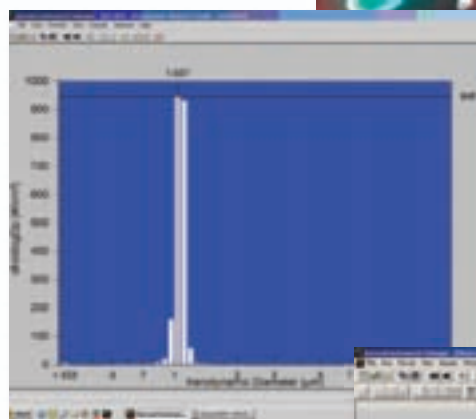
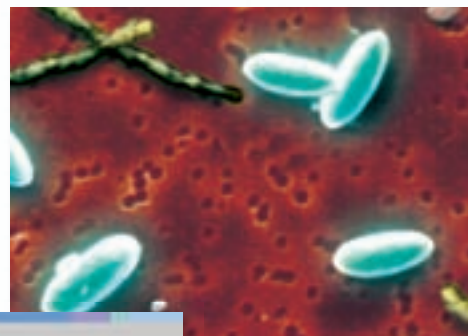
The Model 3314 Ultraviolet Aerodynamic Particle Sizer (UVAPS) spectrometer provides three real-time measurements of airborne particles – aerodynamic size, scattered light intensity, and fluorescence. These three measurements provide researchers the most comprehensive profile of aerosol characteristics available from a single instrument. Because components of biological particles fluoresce when excited with a UV light source, the fluorescence measurement provides the ability to distinguish, in real time, biological aerosol particles from inanimate materials.

Two separate patented detection techniques* are used to make the three measurements. The UVAPS employs the same double-crest optical system used in TSI's Model 3321 Aerodynamic Particle Sizer (APS) spectrometer to measure the aerodynamic diameter and scattered-light intensity of aerosol particles. Particle fluorescence is excited by a pulsed-ultraviolet laser and is collected real time using a photomultiplier tube.

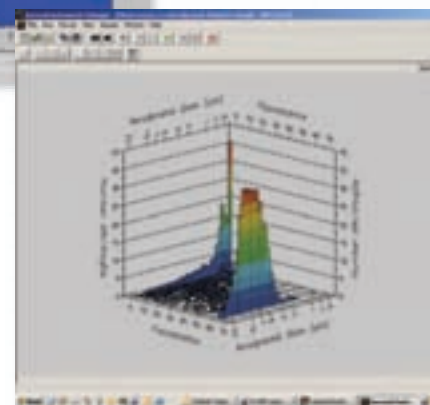
Originally developed to detect the presence of biological agents, the UV-APS technology has numerous applications in bioaerosol investigations including biohazard detection, inhalation toxicology studies, indoor-air quality analysis, and evaluation of particle separation technologies using bioaerosols.

Produced under licence from the Canadian Department of National Defence.

*United States patent numbers 5,561,515, 5,701,102, 5,895,922, and 5,999,250.



The Aerosol Instrument Manager software provides a variety of graphing options. Shown at left is aerodynamic size vs. number; the 3-D graph, below, shows fluorescence vs. aerodynamic size.



Particle Sizers and Imaging Systems



Additional possibilities for particle research.

Global Sizing Velocimeter Model GSV

For simultaneous size and velocity measurements.

GSV is an imaging-based system that provides simultaneous measurements of the size and velocity of individual droplets, bubbles, or spherical particles in an area. It utilizes a laser light sheet to illuminate a region of the particle field. Imaging-based measurement methods feature the significant advantage of providing thousands of individual droplet or particle size/velocity measurements from a single image. The simultaneous nature of the measurements makes advanced analysis, such as size and velocity correlations, simple, making it an attractive measurement solution for a variety of industrial and research applications.

Phase Doppler Particle Analyzer Model PDPA

A noninvasive instrument that measures particle, droplet, or bubble size.

Phase Doppler technique allows for the sizing of spherical particles (typically spray droplets, bubbles, and hollow or solid spheres). Along with size information, the velocity of the particle is obtained. Typical limits for common configurations are 0.5 μm on the lower end and 5 mm on the upper end.

The Phase Doppler Particle Analyzer (PDPA) uses the principles of light-scattering interferometry. It requires no calibration because particle size and velocity are dependent only on the laser wavelength and optical configuration. PDPA technique does not depend upon scattered-light intensity and is not subject to beam attenuation or deflection that occurs in dense particle and combustion environments. Consequently the technique works well in dense spray and combustion measurements.

PDPA systems are used in a wide variety of disciplines around the world, including combustion research, aircraft icing research, ink-jet printer development, industrial sprays research, spray drying, characterization of metered dose inhalers, droplet size and velocity measurements of medical nasal sprays, and characterization of paint sprays.



TSI leads when it comes to instruments for particle counting, aerosol detection, and particle concentration measurement.

Ultrafine Water-based Condensation Particle Counter

Model 3786

Detects particles as small as 2.5 nm at an aerosol flow rate of 0.3 L/min.

The Model 3786 UWPC is designed primarily for researchers interested in airborne particles smaller than 20 nm. It features a special sheath-air flow design that improves response time and produces a sharp lower cutoff size, and single particle counting with continuous, live-time coincidence correction for accurate measurements. This UWPC is well suited for atmospheric and climate research, particle formation and growth studies, environmental monitoring, nanotechnology research, and mobile aerosol studies.

Water-based Condensation Particle Counter

Model 3785

This WCPC detects particles down to 5 nm at concentrations up to 10^7 particles/cm³.

The Model 3785 WCPC is a general-purpose counter that features a fast response and an aerosol flow rate of 1.0 L/min. It uses two detection modes, continuous, live-time coincidence corrected single particle counting and photometric counting, for accurate measurements at concentrations up to 10^7 particles/cm³. We recommend the Model 3785 for basic aerosol research, environmental monitoring, atmospheric research, health effects studies, inhalation and exposure studies, and mobile aerosol studies.

Ultrafine Condensation Particle Counter Model 3776

Detects particles down to 2.5 nm with extended single particle counting up to 300,000 particles/cm³.

The Model 3776 UCPC is designed primarily for researchers interested in airborne particles smaller than 20 nm. It uses a special sheath-air flow design that improves response time and increases counting efficiency. It features single particle counting with a continuous, live-time coincidence correction for accurate measurements, an anti-spill design, water-removal capability, built-in data logging and storage capabilities, a removable memory card, and USB and Ethernet connectors. This UCPC is ideally suited for atmospheric and climate research, particle formation and growth studies, combustion and engine research and nanotechnology applications.

Condensation Particle Counter Model 3775

This CPC detects particles down to 4 nm at concentrations up to 10⁷ particles/cm³.

The Model 3775 CPC is a general-purpose counter that accurately measures concentration over a wide range. It features two detection modes, an extended single particle counting with continuous, live-time coincidence correction, plus photometric counting for concentrations up to 10⁷ particles/cm³. Model 3775 also features an improved transition between the two counting modes, anti-spill design, water-removal capability, data logging and storage capabilities, a removable memory card, and USB and Ethernet ports. We recommend this CPC for basic aerosol research, environmental monitoring, health effects studies, inhalation and exposure studies, combustion research and more.

Condensation Particle Counter Model 3772

A compact, full-featured CPC that detects particles down to 10 nm.

The Model 3772 utilizes single particle counting with continuous, live-time coincidence correction to accurately measure concentrations up to 10⁴ particles/cm³. It's ideally suited for applications that do not require measurement of high concentrations, including basic aerosol research, filter and air-cleaner testing, particle counter calibration, particle shedding and component testing, and more. This CPC also features an anti-spill design, water-removal capability, built-in data logging and storage, removable memory card, and USB and Ethernet ports. It requires an external vacuum pump (sold separately).

Condensation Particle Counter Model 3771

A low-cost CPC for measuring particles down to 10 nm.

Our basic CPC offers surprising performance features. It detects particles as small as 10 nm and utilizes single particle counting with continuous, live-time coincidence correction to accurately measure concentration up to 10⁴ particles/cm³. It features an anti-spill design, water-removal capability, and has USB and Ethernet ports. An external vacuum pump is required (sold separately). This makes the Model 3771 a good choice for basic aerosol research, filter testing, and particle shedding and component tests.

CPC Accessories (available separately)

376060	Particle Size Selector (page 34)
376061	Additional diffusion screens for Particle Size Selector (Qty. 12)
3032	Vacuum Pump for 3771 and 3772 CPCs (page 35)

Model	3786	3785	3781	3776	3775	3772	3771	3007
Minimum Particle Size (nm, 50% efficiency)	2.5	5	6	2.5	4	10	10	10
Upper Concentration Limit (particles/cm ³)	10 ⁵	10 ⁷	5 x 10 ⁵	3 x 10 ⁵	10 ⁷	10 ⁴	10 ⁴	10 ⁵
Response Time (sec, 95% response)	<2	<2	<2	<1 [†]	<4 [†]	<3	<3	<9
Aerosol Flow Rate (cm ³ /min)	300	1000	120	50	300	1000	1000	100
Condensing Liquid	Water			n-butyl alcohol				Isopropanol
SMPS [‡] Compatibility	Yes		No	Yes			No	
Data Logging Capability	No		Yes				No	Yes
AIM Software	Yes							
Display Type	VFD [§]		LCD	Color VGA		LCD	None	LCD
Vacuum Source	Internal					External		Internal

[†]High-flow mode

[‡]Series 3936 Scanning Mobility Particle Sizer spectrometers

[§]Vacuum Florescence Display

Hand-held Condensation Particle Counter Model 3007



3007

A portable, battery-powered CPC that detects particles down to 10 nm.

The Model 3007 is a hand-held CPC intended for measuring ultrafine particles in a wide variety of applications. Its small size and ergonomic design make it the best choice for short-term outdoor and indoor air quality monitoring, nanoparticle work area surveys, and mobile aerosol research. This highly portable CPC weighs only 1.7 Kg (3.8 pounds)!

Micro-environment Water-based Condensation Particle Counter Model 3781



3781

Our lowest-cost-per-point WCPC for indoor and outdoor monitoring.

The Model 3781 Micro-environment WCPC (ME-WCPC) detects airborne particles as small as 6 nm. Using single particle counting with continuous, live-time coincidence correction, it accurately measures particle concentration up to 5×10^5 particles/cm³. The ME-WCPC features internal data logging, small size and light weight, making it an ideal choice for monitoring the spatial variation of indoor air quality and outdoor environments, as well as for mobile aerosol studies.

Aerosol Electrometer Model 3068B



3068B

Measures net charge or concentration of aerosol.

Our Aerosol Electrometer has been updated to make use of new technologies that were developed for our Electrical Aerosol Detector and Engine Exhaust Particle Sizer™ spectrometer. It measures the total net charge on aerosol particles from 0.002 to 5 μm at a user-selectable flow rate from 1 to 10 L/min. When paired with a TSI Electrostatic Classifier, the electrometer measures the number concentration of monodisperse aerosol. This configuration is used primarily for calibrating and testing particle instruments like CPCs. Data are presented on the front-panel display in real time and also as an analog voltage output for data recording. The electrometer is compatible with the Aerosol Instrument Manager software. An external vacuum pump is required (sold separately).

Nanoparticle Surface Area Monitor Model 3550*



3550

Measures lung-deposited surface area of inhaled particles.

Recent research has shown that the surface area of nanoparticles is highly correlated to exposure related adverse health effects. The Model 3550 indicates the surface area of nanoparticle aerosols that deposit in the lung. The reported measurements correspond to the ICRP lung deposition curves for the tracheobronchial (TB) and alveolar (A) regions of the human respiratory tract. The Model 3550 measures particles in the size range of 10 to 1000 nm. This is an important instrument for research in the fields of inhalation toxicology, health effects, and epidemiology, and for measuring and monitoring workplace exposure. Model 3550 offers user-selectable measurement modes, comprehensive software, continuous operation, a wide dynamic range, and high time resolution.

*U.S. Patents 6,544,484 and 7,812,306

DUSTTRAK™ II & DRX Aerosol Monitors
Models 8530, 8531, 8532, 8533 & 8534



Simply leaves everyone else in the dust.

The new DUSTTRAK II and DRX Aerosol Monitors are battery-operated, data-logging, light-scattering laser photometers that give you real-time aerosol mass readings.

These monitors measure aerosol contaminants such as dust, smoke, fumes and mists. They use a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. Suitable for clean office settings as well as harsh industrial workplaces, construction and environmental sites and other outdoor applications.

Ideal applications include industrial/occupational hygiene surveys, indoor air quality investigations, outdoor environmental monitoring, fugitive emissions monitoring, site perimeter monitoring, dust control operations, environmental research studies, baseline trending and screening, engineering control evaluations, point source monitoring, engineering studies, remote monitoring, process monitoring, emissions monitoring and aerosol research studies.

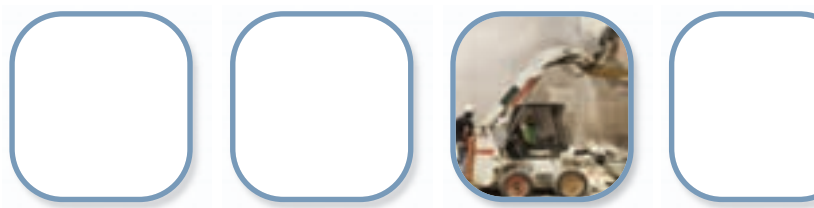
Personal Aerosol Monitor
Model AM510 SIDEPAK™



A personal, battery-operated laser photometer that measures and records worker exposure to dust.

The SIDEPAK Personal Aerosol Monitor is a rugged, lightweight, belt-mounted laser photometer that weighs as little as 16 ounces. A built-in sampling pump allows the use of a variety of size-selective inlet conditioners. Model AM510 includes TSI's Smart Battery Management System™, which includes long-running NiMH or alkaline battery packs and indicates run time in minutes remaining. An easy-to-read display shows real-time aerosol mass concentration and 8-hour time-weighted average (TWA). Data logging and long battery life make the AM510 ideal for work shift or extended sampling. Available in single- and three-unit kits. Each unit is calibrated easily using optional primary calibrators.

Features	DUSTTRAK II Model 8530	DUSTTRAK II Model 8531	DUSTTRAK II Model 8532	DUSTTRAK DRX Model 8533	DUSTTRAK DRX Model 8534
Particle Size Range	0.1 to 10 µm			0.1 to ~15 µm	
Aerosol Concentration Range	0.001 to 150 mg/m ³	0.5 to 400 mg/m ³	0.001 to 150 mg/m ³	0.001 to 150 mg/m ³	
Measurement Output	Single Mass Concentration (PM ₁₀ , Respirable, PM _{2.5} , or PM ₁)			Simultaneous Size Segregated Mass Fractions for PM ₁ , PM _{2.5} , Respirable, PM ₁₀ and Total. All Displayed.	
Gravimetric Reference Filter	Yes		No	Yes	No
Data Logging	5 MB of on-board memory (>60,000 data points); 45 days at 1 minute logging interval.				
Hand-held	No		Yes	No	Yes
Desktop	Yes		No	Yes	No



Air Filter & Respirator Testers



3160



3140



8127/8130



3120

Our automated air filter and respirator testers are known for simple reliable operation. Component systems are also available.

Model	8127 ^a	8130 ^a	3120	3160	3140
Measurement Application	Loading and Quality Control Tests			Penetration vs. Particle Size	Quality Control Test
Maximum Efficiency	99.999%			99.99999%	99.99999%
Aerosol Type ^b	DOP, PAO, DEHS, Paraffin, and other Oils	DOP, PAO, DEHS, Paraffin, and other Oils or NaCl	DOP, PAO, DEHS, Paraffin, and other oils	DOP, PAO, DEHS, and other Oils or NaCl	DOP, PAO, DEHS, Paraffin, and other Oils
Aerosol Generation	Atomizer			Atomizer with Classifier	Atomizer
Count Median Diameter ^c	0.2 µm (Oil)	0.2 µm (Oil) or 0.075 µm (NaCl)	0.2 µm (oil)	N/A	0.19 µm
Geometric Standard Deviation ^c	<1.6 (Oil)	<1.6 (Oil) or < 1.86 (NaCl)	<1.6 (oil)	<1.3	<1.6
Flow Rate	15 to 100 L/min		100 to 500 L/min	5 to 100 L/min	
Resistance	0-150 mm H ₂ O (0-1470 Pa)				
Particle Detection	Light Scattering Photometer			Condensation Particle Counter	
Typical Test Length ^d	10 sec			30 sec to 20 min	< 1 min
Data Reporting	Alpha-Numeric Display and RS-232			PC with Integrated Software	
Operation	Stand Alone Tester/Automated Production Lines			Stand Alone Tester	
Compliance	US 42 CFR part 84, EN 143, JMOL, ISO 23328-1		Proposed PAPR Std.	EN 1822 parts 3 and 5	N/A

^a EN versions (for equivalent results to EN 143 standard) available (8127-1-EN, 8130-1-EN)

^c EN version CMD and GSD are different. See 8127/8130 spec sheet for more info

^b Aerosol abbreviations: DOP (dioctyl phthalate), PAO (polyalpha olefin), DEHS (di-ethylhexyl sebacate)

^d Efficiencies higher than 99.9999% require longer than typical testing times

Automated Filter Tester Models 8130 & 8130-EN

Filter testers for commercial respirator and military mask testing.

Model 8130 is designed for simple, fast and automated operation. That is why it excels for quality-control and production-testing applications. It can also be used for certification testing of all respirator filter categories in accordance with US 42 CFR part 84, as well as for other standards around the globe. For customers that need to test according to European standard EN 143, TSI now offers the Model 8130-EN tester.

Models 8130 and 8130-EN can measure efficiencies up to 99.999%, or penetrations as low as 0.001%, using either polydisperse oil or sodium chloride aerosol. Both testers produce oil aerosol without heat, so a variety of oils can be used. Dual light scattering photometers provide simultaneous upstream and downstream particle concentration measurements to ensure fast, repeatable results. A touch-panel display makes these testers extremely easy to use, so very little operator training is needed. On-screen menus enable operators to easily change test parameters to accommodate special requirements. An internal microprocessor controls the tester and calculates and displays filter penetration, resistance value and flow rate. Additionally, it performs self-diagnostic checks during operation and automatically zeros the tester between measurements to ensure accurate, stable, and reproducible results.

Automated Filter Tester Models 8127 & 8127-EN

Oil-only filter testers for commercial respirator and military mask testing.

Model 8127 includes all of the features of our Model 8130, except it is an oil-only tester. It can be used for quality control and certification testing in accordance with US 42 CFR part 84, as well as for other standards around the globe. For customers that need to test according to European standard EN 143, TSI now offers the Model 8127-EN tester.

Models 8127 and 8127-EN can measure efficiencies up to 99.999%, or penetrations as low as 0.001%, using polydisperse oil aerosol. Both testers produce oil aerosol without heat, so a variety of oils can be used. Dual light scattering photometers provide simultaneous upstream and downstream particle concentration measurements to ensure accurate, fast, and repeatable results.

High-airflow Automated Filter Tester Model 3120

A high-airflow tester designed specifically for PAPR filters.

Model 3120 meets NIOSH's proposed Powered Air Purifying Respirator (PAPR) filter test requirements. It is an oil-only tester that has an airflow range of 100 to 500 L/min and can measure efficiencies up to 99.999%, or penetrations as low as 0.001%. In fact, Model 3120 uses the same proven oil-aerosol generator found in models 8127 and 8130. Like models 8127 and 8130, model 3120 features dual light scattering photometers that simultaneously measure upstream and downstream particle concentration to ensure fast, repeatable results.

A touch-panel display makes the Model 3120 easy to use, so very little operator training is needed. On-screen menus enable users to easily change test parameters to meet specific requirements of different filters. A microprocessor controls the tester and calculates and displays filter penetration, resistance value and flow rate. Self-check diagnostics and automatic zeroing between tests ensures accurate, stable, and reproducible results.

Respirator Leak Tester Model 8119

Turns Models 8127 and 8130 into respirator leak testers.

This accessory enables Models 8127 and 8130 to perform fast, easy, after-maintenance leak tests on full-face and half-mask air-purifying respirators. After installing the 8119, simply mount the respirator on the headform and scan the respirator with the hand-held probe. Test critical areas like eye-lens seals and exhaust valves. Audible and visual alarms are triggered if the aerosol concentration inside the mask exceeds a preset level.



The Respirator Leak Tester accessory attaches easily to Models 8127 and 8130.

[See additional filter testers and accessories on the following page.](#)



Automated Filter Tester Model 3160



Determines penetration vs. particle size of filters and filter media.

Model 3160 is the most advanced automated tester available for challenging filters and filter media with submicrometer aerosols. It can be used to test both low- and high-efficiency filters and filter media, up to 99.999999% efficient (eight 9's), or penetrations down to 0.000001%.

The 3160 uses a bank of atomizers and the TSI Electrostatic Classifier to challenge a filter or filter media with known-size, monodisperse particles. Two Condensation Particle Counters (CPCs) simultaneously count the upstream and downstream particles and computer software calculates the penetration value. Filters can be sequentially challenged with up to 20 different monodisperse particle sizes in the range from 15 to 800nm. The penetration value for each particle size is calculated. At the end of a test, the 3160 generates a curve of penetration vs. particle size and produces a summary of test results, including the most penetrating particle size (MPPS). Test results can be automatically saved in a Microsoft Access® data base and downloaded into Microsoft Excel®.

Model 3160 complies with EN 1822-3 and provides the most complete information on filter penetration available from any filter tester. You'll find it invaluable for product development and quality control.

Automated Filter Tester Model 3140



Filter tester for quality control measurements of high-efficiency filters.

Model 3140 utilizes the same, proven, oil-aerosol generator technology found in Models 8127 and 8130. It produces oil aerosol without heat, so a variety of oils can be used. Two Condensation Particle Counters (CPCs) simultaneously count upstream and downstream particles. This enables quick, accurate, and repeatable measurements of filters with efficiencies as high as 99.999999% (eight 9's), or penetrations down to 0.000001%. A filter with 99.9999% efficiency can be tested in less than 15 seconds; higher efficiencies take slightly longer. The data output is displayed on a computer screen and can be automatically saved in a Microsoft Access® data base and downloaded into Microsoft Excel®.

Laser Photometer Model 8587A



8587A

A compact, reliable photometer for customized filter testing.

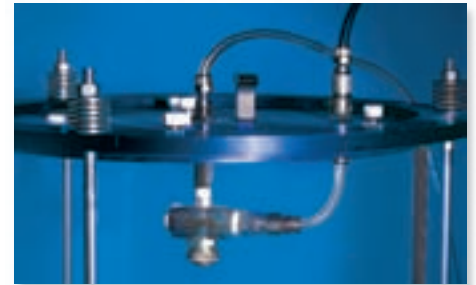
This photometer features a reliable laser diode that produces constant laser power, so aerosol concentration measurements remain stable over a long period of time. A sheath-air design keeps the optics clean for low background levels and also minimizes maintenance requirements. The 8587A utilizes an internal switching valve to measure both the upstream and downstream aerosol concentration. A special high-speed "purge" mode shortens the purge time when switching between upstream and downstream measurements. A simple command set can be incorporated into your LabVIEW® program to give you complete flexibility in test protocol and database management. All of these features combine to make the 8587A ideally suited for custom filter testing applications.

Large-particle Aerosol Generator Model 8108

Generates high-concentration aerosols up to 10 µm in diameter.

The Large-particle Aerosol Generator produces highly concentrated aerosol over a wide particle-size range, from 0.1 to 10 µm. Designed for easy cleaning, this generator produces potassium chloride (KCl) and other aerosols. Model 8108 meets the requirements of ASHRAE 52.2 for KCl test aerosol and can also be used for ISO/TS 11155-1:2001 filter efficiency testing. It is an ideal aerosol generator for fractional efficiency testing of general ventilation filters and automotive cabin-air filters.

Model 8108 produces high-concentration aerosol in the range from 0.1 to 10 µm. (Full instrument photo on page 30)



Component Filter-testing Systems

Build a customized filter tester using reliable TSI components.

TSI AFT's are complete, self-contained, ready-to-use instruments designed to meet most filter testing requirements. Should you have a need to build your own tester, TSI can help you put together a component system made up of TSI particle instruments. See individual descriptions of our Aerodynamic Particle Sizer® spectrometer, Scanning Mobility Particle Sizer™ spectrometers, Condensation Particle Counters, aerosol generators, and powder dispersers described elsewhere in this catalog. Discuss your requirements with a TSI representative, and we'll help specify a system that's perfect for your application.



Courtesy of Topas GmbH, Dresden, Germany

Ultrafine Particle Monitor Model 3031



Provides continuous size distribution and number concentration data for long-term, air quality monitoring.

The Model 3031 Ultrafine Particle (UFP) Monitor has been specifically designed for long-term, air quality monitoring networks. It operates continuously, 24-hours a day, for months on end, with minimal maintenance and requires no working fluids. The UFP Monitor has no radioactive source, so there are no special licensing requirements and no restrictions for its use or where it can be installed. The Model 3031 fits into a standard 19-inch, rack mount cabinet, which allows it to be easily installed into existing roadside and urban air quality monitoring stations. A bench top version of this instrument (the Model 3031-1) is available for laboratory or mobile applications.

Environmental Sampling System Model 3031200



Provides representative sampling and proper conditioning of ambient submicrometer aerosol for accurate size distribution and particle number concentrations.

The Model 3031200 Environmental Sampling System is an accessory for use with a wide variety of TSI particle sizers and counters, including the Ultrafine Particle Monitor, Scanning Mobility Particle Sizer™ spectrometers and Condensation Particle Counters. The Model 3031200 consists of a standard PM₁₀ inlet, a sharp-cut PM₁ cyclone, a flow splitter and a Nafion® dryer. Combine these components with your choice of appropriate length sampling tubes and vacuum source for easy setup in the field.

Integrating Nephelometer Model 3563



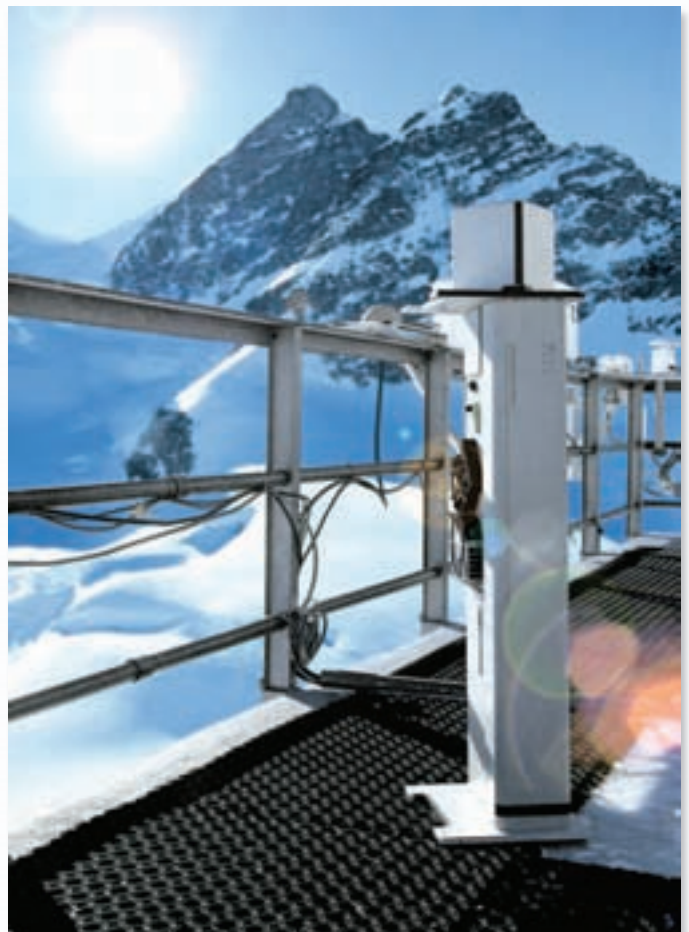
A highly sensitive instrument for determining the light-scattering properties of atmospheric aerosols.

The Integrating Nephelometer is a unique analytical instrument useful for short- or long-term measurements of the light-scattering coefficient of atmospheric and laboratory aerosols. It is particularly well-suited for measurements related to climate, visibility, and air quality. It offers sensitivity to light scattering coefficients lower than 1.0×10^7 meter⁻¹ (blue and green wavelengths, 30-sec averaging time). That's as much as two orders of magnitude better than other commercial instruments!

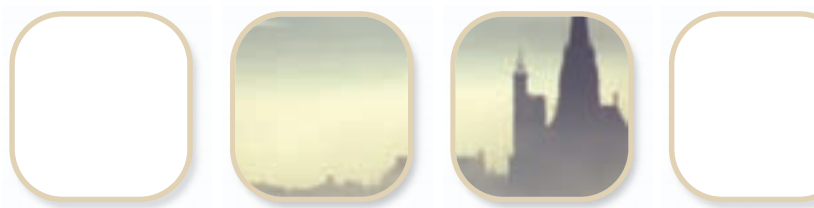
TSI Model 3563 has the advantage of selectable averaging time, allowing data to be tailored to different test requirements. It includes temperature and humidity sensors, and it possesses high vacuum integrity. Therefore, it produces accurate measurements, even when positioned inside pressurized aircraft cabins or smoke-filled environments.

This three-color nephelometer allows you to measure both total and backscatter signals, and it operates under complete computer control. Software and a separate power supply (not pictured) are included with the instrument.

The Integrating Nephelometer incorporates developments patented by the University of Washington. Refer to United States Patent Numbers 3,563,661; 3,700,333; and 3,953,127.



Nephelometer at Jungfraujoch in Switzerland courtesy of Dr. Stephan Hyeki





Ford Research Center, Aachen

Engine Emissions



3090



Engine Exhaust Particle Sizer™ Spectrometer Model 3090

The best tool for measuring transient particle emissions and characterizing exhaust after-treatment devices.

The Engine Exhaust Particle Sizer (EEPS™) spectrometer measures the size distribution of engine particle emissions in the range from 5.6 to 560 nm with the fastest time resolution available (10 times per second!). Users can visualize and study the dynamic behavior of emissions that occur during transient test cycles, such as changes in engine speed, torque, or load. They may also measure emissions that occur during the first few seconds of a cold start or during regeneration of a particle trap or diesel particulate filter (DPF).

Measurements are displayed with high size resolution (32 total channels, 16 channels per decade). The EEPS spectrometer operates over a wide particle concentration range. This makes it well-suited for measuring upstream and downstream of a particle trap or DPF to determine soot loading and removal efficiency. The EEPS operates at ambient pressure to prevent evaporation of volatile and semivolatile particles, it requires no consumables, and it uses an efficient, unipolar charger to eliminate the need for a radioactive neutralizer.

Ease of operation is a key feature of this instrument. All components, including the vacuum source, are housed in a single cabinet that weighs just 32 kg (~70 lbs). Just turn on the power and allow the instrument to warm up. A microprocessor corrects for

volumetric flow and barometric pressure automatically. This will maintain calibration and provide accurate particle size distribution information. The EEPS also features an external “start” input trigger for remote operation, two analog inputs to log and correlate other engine parameters, and four user-configurable analog outputs to integrate emission measurements with the test cell host computer.

EEPS software is unmatched in the industry. It allows users to display measurements in a variety of graphical and tabular formats, including 3-D viewing of size distribution and concentration versus time. These can be replayed for a unique “movie” view of the entire engine cycle, or you can zoom in on a period of interest. The software includes a data export capability and allows users to input individual effective densities per particle size channel to calculate a continuous output of total particulate mass.

EEPS Accessories (available separately)

379020-30 Rotating Disk Diluter with Thermal Conditioner Air Supply (page 24)

The EEPS spectrometer was developed by TSI Incorporated under license from Airel, Ltd. of Tartu, Estonia. Additional assistance was provided by the University of Minnesota Center for Diesel Research. U.S. Patent No. 7,230,431

Engine Exhaust Condensation Particle Counter Model 3790



The particle number (PN) concentration benchmark for proposed ECE Regulations 83 and 49.

The Engine Exhaust Condensation Particle Counter (EECPC) accurately measures PN concentration of exhaust emissions. In fact, the GRPE Particle Measurement Programme (PMP) recently concluded that PN measurements using a CPC plus thermodilution are 20 times more sensitive and much less variable than the traditional method (i.e. gravimetric filter analysis). As a result, the measurement of solid PN emissions has been proposed in Regulation 83 (Euro 5) for certification of new passenger vehicles with diesel engines, and later for Regulation 49 (EURO 6) for heavy-duty engines.

Model 3790 EECPC is fully compliant for light-duty vehicle certification in accordance with all proposed Regulation 83 requirements. Built upon the proven rugged, reliable, and highly repeatable performance of the Model 3010D CPC, the Model 3790 EECPC incorporates a wide assortment of design improvements and features such as anti-spill design, condensate removal, removable saturator for ease of maintenance, built-in microprocessor with USB, RS-232 and Ethernet communication interfaces, touch-panel membrane keys and display enabling instrument set-up, viewing particle concentration and count data, interrogating instrument status, and data storage capabilities. The EECPC includes our Aerosol Instrument Manager® software. An external vacuum pump is required – sold separately.

Proposed ECE Regulations 83 and 49 mandate that only the number concentration of solid particles are measured. TSI offers the Rotating Disk Diluter with Thermal Conditioner Air Supply to eliminate or suppress the formation of volatile compounds so that the EECPC only counts solid particles. Together, the Models 3790 and 379020-30 fulfill the proposed solid PN sampling and measurement requirements as shown in Figure 1.

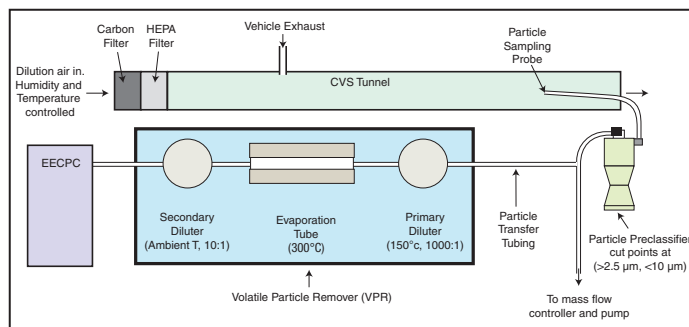


Figure 1. Proposed Regulation 83 Particle Sampling and Measurement.

EECPC Accessory (sold separately)

- 3032 Vacuum Pump, 115 VAC (page 35)
- 3032-EC Vacuum Pump, Europe only (page 35)
- 3032-1 Vacuum Pump, 230 VAC (page 35)
- 379020-30 Rotating Disk Diluter with Thermal Conditioner Air Supply (page 24)

Electrical Aerosol Detector Model 3070A



A simple, low-cost tool for measuring particle emissions second-by-second.

The Electrical Aerosol Detector (EAD) is a robust instrument that provides highly repeatable, real-time measurements in the range from 10 to 1000 nm. It operates over a wide concentration range and requires no working fluid or consumables. When combined with a TSI Rotating Disk Thermodiluter, the EAD becomes a real-time solid PM detector. Such features make the EAD ideally suited to evaluate particle emissions during transient engine operation, characterize efficiency of exhaust after-treatment devices, and for on-board emissions testing.



Rotating Disk Thermodiluters and Thermal Conditioner Air Supply Models 379020, 379021 & 379030



Dilute and condition combustion sources to preserve the original particle size distribution and number concentration for accurate measurements.

TSI Model 379020 and 379021 Rotating Disk Thermodiluters are highly regarded in the field of particle emission measurement, especially for sampling, diluting, and conditioning exhaust emissions from diesel and spark-ignition engines, as well as for performing stack emission studies.

The Model 379020 features a separate diluter head and control unit, which allows the sample to be diluted and thermally conditioned at the point of measurement (i.e. tailpipe, CVS tunnel, or stack). It also features a variable dilution ratio that is adjustable from 15:1 to 3000:1 and selectable heated diluter temperatures up to 150°C to avoid measurement of condensed volatile materials.

The Model 379021 combines the rotating disk diluter and control unit in a compact, convenient package. It features a variable dilution ratio that is adjustable from 12:1 to 2400:1 and selectable heated diluter temperatures up to 80°C.

In order to measure only the solid particle emissions, it is necessary to further thermally condition the sample in order to eliminate the semi-volatile and volatile fractions. TSI offers the Model 379030 Thermal Conditioner Air Supply that can be combined with the Model 379020. It uses an evaporation tube to heat the sample up to 400°C, which effectively eliminates volatile compounds that may have formed in the exhaust as it cools or becomes diluted.

Rotating Disk Thermodiluters and accessories can be used with all of our submicrometer particle sizers, especially the EEPS™ and SMPS™ spectrometers, all of our CPCs, and the EAD.

Thermodiluters

- 379020 Rotating Disk Thermodiluter
- 379021 Rotating Disk Thermodiluter
- 379020-30 Rotating Disk Diluter with Thermal Conditioner Air Supply

Thermodiluter Accessories (sold separately)

- 379030 Thermal Conditioner Air Supply

Model 379020 Accessories (sold separately; must be ordered together with Model 379020 for proper fitting)

- 379025 Housing for Diluter Head
- 379026 Cyclone (PM_{2.5})

These instruments are produced in Switzerland by Matter Engineering AG.



379021



379020



Aerosol Generators and Dispensers



Collectively, our generators and dispensers produce particles in the range of 0.002 to 200 micrometers.

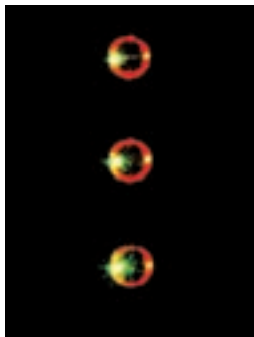
Model	Monodisperse Generators				Powder Generators		Polydisperse Generators					
	3450	Series 3080	3475	3480	3400A	3433*	3076*	3079*	9302*	9306*	8108	
Particle size range (µm)	1 to 200 [†]	0.002 to 1.0	0.1 to 8.0	0.002 to 0.1	0.5 to 40 [‡]	1.0 to 50 [‡]	0.01 to 2.0 (nominal 0.3-µm count mean diameter)					0.1 to 10.0
Particle concentration	<10 ³ /cm ³	<10 ⁵ /cm ³	>10 ⁶ /cm ³	>10 ⁷ /cm ³	10 to 100 mg/m ³	0.3 to 40 [§] mg/m ³	>10 ⁷ /cm ³	>10 ⁸ /cm ³	>10 ⁷ /cm ³	>10 ⁷ /cm ³	10 ⁴ /cm ³	
Nominal flow rate (L/min)	30 to 80**	≤2	3.5 to 4	0.25 to 3	5 to 15	5	3.0 to 3.5	1.0 to 4.2	6.5	6.5 to 39 ^{††}	140	

*May be used to disperse monodisperse solid particles such as PSL. †Large sizes require optional orifices. ‡Aerodynamic diameter. §High concentrations require optional high-speed motor.
 **Includes dilution air; nominal dispersion air flow rate is 1.5 L/min. ††Flow rate at 25-psig inlet pressure; higher pressures and flow rates possible

Vibrating Orifice Aerosol Generator Model 3450

Creates uniform, monodisperse particles in the range of 1 to 200 μm with unmatched accuracy.

The Vibrating Orifice Aerosol Generator (VOAG) is a highly accurate source of monodisperse particles in the range of 1 to 200 μm . Using a variety of solutes and solvents, the VOAG creates solid or liquid aerosol particles uniform in size, shape, density, and surface characteristics.



A micro-orifice inside the generation head vibrates during operation, producing highly uniform particles in solid or liquid form. (Photo courtesy of Prof. Richard K. Chang)

The VOAG produces uniform particles by controlling the breakup of a liquid jet. It delivers a consistent volume of liquid using a constant-flow syringe pump. Its consistency and accuracy make this aerosol generator an effective choice for applications like basic aerosol research, instrument calibration, and product design and development. Standard orifices are included for small particle sizes; additional orifices are available for producing larger particles.

VOAG Accessories (available separately)

- 3054 Aerosol Neutralizer (page 33)
- 3074B Filtered Air Supply (page 33)
- 393520 10- μm orifice (one included with instrument)
- 393530 20- μm orifice (two included with instrument)
- 393540 35- μm orifice
- 393550 50- μm orifice
- 393560 100- μm orifice
- 393590 0.5- μm filters, 13-mm diameter (quantity of 100, one set included with instrument)

The Model 3450 VOAG is part of the Model 3941 Supermicrometer Monodisperse Aerosol Generation System described on page 31.

Electrostatic Classifiers Model 3080

Primary-standard instruments that produce highly monodisperse, submicrometer aerosols.

The Series 3080 Electrostatic Classifiers are primary-standard aerosol instruments that give you highly monodisperse, submicrometer aerosol from a polydisperse source. Our Classifiers have been used in a variety of aerosol-generation or particle-sizing applications with highly repeatable results.

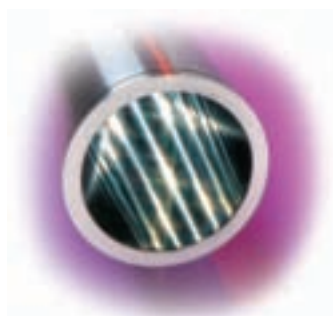
Electrostatic Classifiers neutralize polydisperse aerosol and use a differential mobility analyzer (DMA) to classify and strip out a narrow, predictable size. TSI provides a choice of two DMA columns. You can purchase both columns and interchange them on the same platform, giving you unheard-of versatility. The platform is available separately for use with your own DMA.

Particles produced with our Electrostatic Classifiers range in size from 0.002 to 1.0 μm , collectively. For monodisperse aerosol generation, simply dial in the desired particle size.

Electrostatic Classifiers

- 3080L Electrostatic Classifier with Long DMA, Aerosol Neutralizer, and Inlet Impactor
- 3080N Electrostatic Classifier with Nano DMA, Aerosol Neutralizer, and Inlet Impactor
- 3080 Classifier Platform with Aerosol Neutralizer but no DMA or Impactor Inlet
- 308003 Classifier Platform without DMA, Aerosol Neutralizer, and Impactor Inlet
- 3081 Long DMA (0.01 to 1 μm , included with 3080L)
- 3085 Nano DMA (0.002 to 0.15 μm , included with 3080N)

Electrostatic Classifiers are included in our SMPST[™] systems (page 5). Model 3080L is part of the Model 3940 Submicrometer Monodisperse Aerosol Generation System (page 31). DMA columns are interchangeable. See page 33 for restrictions on Aerosol Neutralizers. The Nano DMA was developed in cooperation with the University of Minnesota Particle Technology Laboratory and Gerhard Mercator University. Refer to United States Patent Number 6,230,572.



DMA's contain highly polished surfaces for high-resolution particle size classification (above). The Series 3080 offers a choice of two DMA's (right).



Condensation Monodisperse Aerosol Generator Model 3475



Generates high-concentration, monodisperse aerosols quickly and accurately.

The Condensation Monodisperse Aerosol Generator (CMAG) is a condensation-type instrument that produces high-concentration, monodisperse aerosol particles. It is well-suited for challenging HEPA and ULPA filters, seeding wind tunnels, conducting inhalation studies, or other applications requiring monodisperse particles in high concentrations.

The CMAG generates liquid or solid particles from a variety of oils, waxes, and other materials, in concentrations greater than 10^6 particles/cm³. It generates monodisperse particles in the range of 0.1 to 8 μm and operates at a flow rate of 3.5 to 4 L/min. Particles can be fluorescently or radioactively labeled. A coil heater inside the saturator and a condensation-nuclei bypass filter provide rapid response when changing aerosol size. The CMAG can operate for long periods without interruption. Aerosol may be monitored for size and concentration using the optional Process Aerosol Monitor.

CMAG Accessories (available separately)

- 3375 Process Aerosol Monitor (page 35)
- 3074B Filtered Air Supply (page 33)

Please specify voltage requirements. Models 3475 and 3375 are produced in Germany by Topas GmbH. Availability is limited in Europe.

Electrospray Aerosol Generator Model 3480



Produces monodisperse particles as small as 2 nanometers.

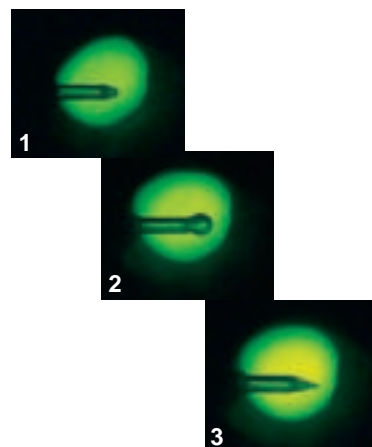
The Electrospray Aerosol Generator (EAG) uses a patented technique to produce high concentrations of monodisperse, submicrometer particles in the range of 2 to 100 nm in diameter. The EAG produces such small, uniform particles by pushing a charged liquid solution or suspension through a capillary tube and exerting an electrical field on the liquid at the capillary tip. The electrical field pulls the liquid from the capillary, forming individual droplets. Air and CO₂ mixed with the droplets evaporate the liquid and the remaining particles are neutralized by an ionizer. The result is a neutralized, monodisperse aerosol. Applications for the EAG include instrument calibration, nanometer-sized powder dispersion, macromolecular analysis, and nano-aerosol studies.

EAG Accessories

- 348002 Replacement neutralizer, one included (page 33)
- 3074B Filtered Air Supply (page 33)

United States Patent Numbers 5,076,097 and 5,247,842

The Electrospray produces particles down to 2 nm. A viewport allows you to watch the capillary tip during operation: (1) no liquid flow, (2) with liquid flow but no electrical field, and (3) with liquid flow and an electrical field. The third view illustrates stable operation.



Small-Scale Powder Disperser Model 3433



Disperses small quantities of powder for powder sizing applications.

The Small-Scale Powder Disperser (SSPD) aerosolizes very small quantities of powder by lifting particles from a turntable using a venturi aspirator. The turntable rotates at variable speeds, controlling aerosol concentrations from 0.3 to 4.0 mg/m³ (up to 40 mg/m³ with optional high-speed motor). Shear forces created in the SSPD are sufficient to deagglomerate most dry particles in the size range of 1.0 to 50 µm.

A selection of optional turntables is available to meet special needs, including one designed to redisperse airborne material collected on 25- and 35-mm membrane filters used during environmental or exposure monitoring. Because it disperses only a small amount of sample, the SSPD is great for studies involving rare, expensive, or hazardous materials. It also effectively disperses polystyrene latex (PSL) spheres used to calibrate measurement instruments. If you want to measure the size distribution of powders, the SSPD can be paired with our Aerodynamic Particle Sizer® spectrometer (page 8).

SSPD Accessories (available separately)

- 3074B Filtered Air Supply (page 33)
- 1030737 Standard turntable (one included with instrument)
- 1030770 Turntable preloaded with 5-, 7-, 10-, 15-, 20-, and 30-µm PSL particles
- 1030771 Membrane-filter turntable
- 1030772 V-groove turntable
- 1030779 High-speed motor for output up to 40 mg/m³



A variety of turntables provides flexibility when using the SSPD.

Fluidized Bed Aerosol Generator Model 3400A



Disperses powders in stable concentrations for dust experiments or particle seeding.

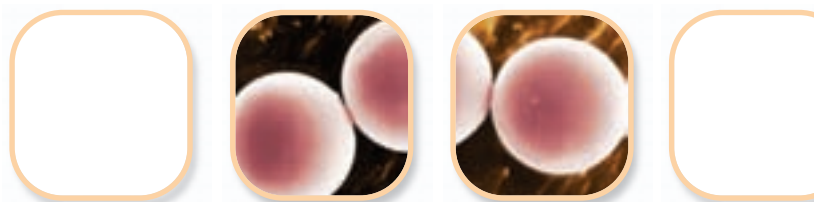
The Fluidized Bed Aerosol Generator (FBAG) is our general-purpose powder disperser. It prepares any dry, free-flowing powder for dispersion in a gas. It disperses powders that range from 0.5 to 40 µm, with concentrations from 10 to 100 mg/m³. Unsurpassed constant output and concentration make the FBAG useful for inhalation toxicology studies, laser-velocimeter seeding, and filter testing.

FBAG Accessories (available separately)

- 3012 Aerosol Neutralizer (page 33)
- 3074B Filtered Air Supply (page 33)
- 1502574 Replacement bronze beads



A bed of bronze beads inside the Model 3400A breaks up powder agglomerates before dispersion.



Atomizers

Models 3076, 3079, 9302 & 9306



Generate polydisperse, high-concentration aerosols.

TSI offers four highly dependable instruments for nebulizing a liquid solution or suspension:

3076 Constant Output Atomizer. Generates aerosols of constant particle size in concentrations over 10^7 particles/cm³ (nominal). Its nominal aerosol flow rate is 3.0 to 3.5 L/min. Stainless-steel components make this Collison-type atomizer suitable for biological and medical research, material synthesis, filter testing, instrument calibration, and basic research.

3079 Portable Atomizer. This rugged, compact atomizer generates particles in concentrations over 10^8 particles/cm³ and offers an adjustable flow rate from 1.0 to 4.2 L/min. A built-in, low-noise compressor provides compressed air, and the atomizer head is made entirely of stainless steel. Operating components are protected by a hood, making this atomizer highly portable and suitable for acceptance tests.

9302 Single-jet Atomizer. Our simplest atomizer includes a built-in pressure regulator for controlling air from an external source. It produces particles in concentrations over 10^7 particles/cm³ at a nominal flow rate of 6.5 L/min.

9306 Six-jet Atomizer. Features the highest flow rate of any TSI atomizer and a built-in dilution system. Users may select up to six jets, each producing particle concentrations greater than 10^7 particles/cm³ at 6.5 L/min (nominal at 25 psig pressure). Built-in dilution air controlled by a valve and rotameter allows you to vary the output particle concentration.

All four atomizers produce a mean droplet diameter of 0.3 μ m with a geometric standard deviation of less than 2.0. They are suitable for work with a wide range of solutions and suspensions, including polystyrene latex (PSL) spheres, dioctyl phthalate (DOP), silicon oil, salt or sugar solutions, and methylene blue.

Please specify voltage requirements when ordering Model 3079. Model 3079 is produced in Germany by Topas GmbH. Availability is limited in Europe.

Large-particle Aerosol Generator

Model 8108



Generates high-concentration aerosols up to 10 μ m in diameter.

The Large-particle Aerosol Generator produces highly concentrated aerosol over a wide particle-size range, from 0.1 to 10 μ m. Designed for easy cleaning, this generator produces potassium chloride (KCl) and other aerosols. Model 8108 meets the requirements of ASHRAE 52.2 and can also be used for ISO/TS 11155-1:2001 filter efficiency testing. It's an ideal aerosol generator for fractional efficiency testing of general ventilation filters and automotive cabin-air filters.

Submicrometer Monodisperse Aerosol Generation System Model 3940



3940

A complete system for generating monodisperse, submicrometer particles.

The Submicrometer Monodisperse Aerosol Generation System gives you the ability to produce monodisperse particles from 0.01 to 1.0 μm in diameter. The system includes:

- o 308003 Electrostatic Classifier Platform (page 27)
- o 3081 Long DMA (page 27)
- o 3077A Aerosol Neutralizer (page 33)
- o 3012 Aerosol Neutralizer (page 33)
- o 3074B Filtered Air Supply (page 33)
- o 3076 Constant Output Atomizer (page 30)
- o 3062 Diffusion Dryer (page 33)
- o 1035900 Inlet Impactor
- o Interconnecting hardware

Supramicrometer Monodisperse Aerosol Generation System Model 3941

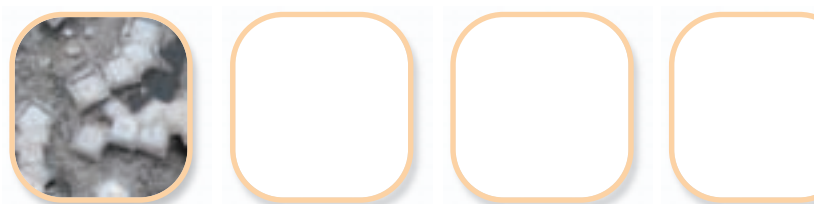


3941

Everything you need to generate monodisperse particles as large as 200 micrometers.

Our Supramicrometer Monodisperse Aerosol Generation System enables you to produce the most monodisperse particles possible in a laboratory. It generates particles from 1 to 200 μm in diameter, from nearly any material that can be put into solution with a volatile solvent. System components include:

- o 3450 Vibrating Orifice Aerosol Generator (page 27)
- o 3054 Aerosol Neutralizer (page 33)
- o 3074B Filtered Air Supply (page 33)
- o 393520 10- μm orifice
- o 393530 20- μm orifice
- o 393540 35- μm orifice
- o 393550 50- μm orifice
- o 393560 100- μm orifice
- o Interconnecting hardware



Nanometer Aerosol Sampler Model 3089



Deposits 2- to 100-nm particles on TEM grids, AFM substrates, or glass slides.

The Nanometer Aerosol Sampler (NAS) allows you to sample charged particles, like those from the output of a Differential Mobility Analyzer (DMA), onto sample substrates for analysis. You control the spot size of the deposition using two electrode sizes and get a uniform deposition spot size that is optimal for your analysis system.

Mass Flowmeter 4000 Series



Measure and monitor experimental flows, simply and accurately.

Our Mass Flowmeters are perfect for measuring flow rates in your experimental setups. They measure mass flow rates of air, O₂, or N₂ up to 200 std. L/min, with exceptional accuracy throughout the range. Plus, they measure flow volume, gas temperature, and absolute pressure. A low pressure-drop design minimizes the impact on your test set-up. Data appears on the LCD display in real time. All models include an analog output for recording the flow rate and an RS-232 computer connection for operational control, data logging, and data display. An in-line HEPA filter is included to protect the flowmeter from particles in the aerosol sample and help maintain calibration.

Please specify voltage requirements.

Mass Flowmeters

- 4043 Flowmeter with LCD (200 L/min, 0.5 inch O.D. Tube)
- 4140 Flowmeter with LCD (20 L/min, 0.25 inch O.D. Tube)
- 4143 Flowmeter with LCD (20 L/min, 0.375 inch O.D. Tube)

Aerosol Neutralizers Models 3012, 3054, 3077 & 348002



Minimize particle losses and coagulation by electrostatic charges, or charge particles properly for size analysis or air-filter measurements.

Aerosol particles dispersed by nebulization, combustion, or powder dispersion are usually electrostatically charged and are subject to high losses during transport. To reduce transport losses and ensure that instruments operating on the electrostatic principle work properly, particles must be neutralized.

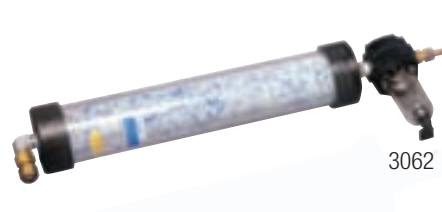
TSI Aerosol Neutralizers use a radioactive source (Kr-85 or Po-210) to perform this function. The radioactive source ionizes the surrounding atmosphere into positive and negative ions. Particles carrying a high charge can discharge by interacting with ions of opposite polarity. After a short time, the particles reach charge equilibrium. TSI recommends models 3012A, 3054A, or 3077A for aerosols with higher charge levels or when operating at higher flow rates or high concentrations.

Aerosol Neutralizers

- 3012 For general-purpose applications with high flow rates (up to 50 L/min)
- 3012A Same as above, but with five times the activity
- 3054 For use with Model 3450 Vibrating Orifice Aerosol Generator (page 27)
- 3054A Same as above, but with twice the activity
- 3077 For general-purpose applications with low flow rates (up to 5 L/min)
- 3077A Same as above, but with five times the activity; included with all Scanning Mobility Particle Sizer spectrometers (page 6)
- 348002 Included with Model 3480 Electrospray Aerosol Generator (page 28)

Provide end-user name and address when ordering Aerosol Neutralizers. TSI has been issued general license number 22-12602-03G by the United States Nuclear Regulatory Commission to sell and distribute these Aerosol Neutralizers. Users in the United States need not apply for additional U.S. Government licenses to handle these products. However, some state and local governments may require special licenses, and some organizations may have special handling procedures. Check all local requirements.

Diffusion Dryer Model 3062



Removes moisture from sample aerosols.

Our Diffusion Dryer includes a removable extractor for collecting large water droplets. Desiccant surrounding the aerosol flowpath removes excess moisture by diffusional capture. Because aerosol never comes in contact with the desiccant, there is minimal particle loss. Regenerate the desiccant simply by removing it from the Diffusion Dryer and baking it at 120°C. Maximum flow rate is 4 L/min.

Filtered Air Supply Model 3074B



Cleans, dries, and regulates compressed air for aerosol generation and other applications.

The Filtered Air Supply removes oil or other liquid droplets from the incoming air using two prefilters. It also removes any remaining moisture in the air stream by passing the air through an advanced membrane dryer. (No more drying of desiccant material!) Plus, it removes fine particles using a high-efficiency filter at the outlet. This full-featured compressed-air conditioner allows you to make pressure adjustments using an included gas-regulator valve. It handles a maximum flow rate of 60 L/min at a dewpoint as low as 2°C. Maximum inlet pressure is 1000 kPa (150 psig).



Flow Splitter Model 3708



Routes sample from one source to several instruments.

The Flow Splitter directs an aerosol sample to as many as four destinations at once. Need only two or three flow paths? Then simply block the unused outlet ports. This accessory is especially useful when performing instrument comparison or calibration experiments. Smooth flow transitions provide equal flow distribution. Stainless-steel construction and an electropolished interior prevent the aerosol from being contaminated. The Flow Splitter has a $\frac{3}{8}$ -inch straight-tube inlet and four $\frac{1}{4}$ -inch outlets (outside diameters). Maximum total flow rate is 30 L/min.

Particle Size Selector Model 376060



Allows selection of different cutoff sizes for CPCs.

The Particle Size Selector (PSS) allows you to control the lower size cutoff of a TSI Condensation Particle Counter (CPC). The PSS is a separating device that selectively removes small particles from an aerosol by diffusion. Simply add or remove diffusion screens to change the lower cutoff size. The cutoff shifts toward larger sizes as more screens are added.

The PSS includes 11 screens and, therefore, can be configured for 11 cutoff sizes. An extra set of 12 screens may be ordered to expand the cutoff range further. Specific cutoff sizes vary based on CPC operating flow rate.

PSS Accessory (available separately)

376061 Set of 12 additional diffusion screens

The technique of using a Condensation Particle Counter with diffusion screens to select specific particle size ranges is covered in United States Patent Number 5,072,626.

Low-flow Thermodenuder Model 3065



Removes precursors and volatile particles from an aerosol sample.

The presence of volatile particles and their precursors from combustion sources can have great influence over the particle size distribution and concentration measurement when the exhaust cools. The Low-flow Thermodenuder is designed to remove precursors and volatile particles from an aerosol sample for subsequent measurement of solid particle size. It is optimized for use with TSI Scanning Mobility Particle Sizer™ (SMPS™) systems (page 5).

The Thermodenuder works by heating the aerosol to a preset temperature (0 to 400°C) and uses activated carbon to adsorb any volatile compounds. It operates within a flow range of 0.2 to 2 L/min, with optimal flow at 0.5 to 1 L/min.

Model 3065 is produced in Germany by Topas GmbH to TSI's design specifications.

Vacuum Pumps Models 3032 & 3033



Use these top-quality pumps when you need a portable vacuum source.

Model 3032 is a diaphragm-type pump that produces flow rates up to 5 L/min. Oversized, permanently lubricated bearings promote longer life and maintenance-free operation. The pump operates in any position. We offer this small, reliable pump for use with our Model 3771, 3772 and 3790 Condensation Particle Counters, or Series 3936 Scanning Mobility Particle Sizer™ spectrometers containing a 3772 CPC.

Model 3033 produces flows up to 60 L/min. This high-quality, rotary-vane pump contains self-sealing, compound-carbon vanes that self-adjust as they wear. Therefore, it always operates at top efficiency. Permanently lubricated ball bearings make the 3033 virtually maintenance-free. This is the pump we recommend for use with our Model 3068B Aerosol Electrometer, or when using multiple CPCs that require an external vacuum source. This pump is also suitable for TSI Model 3306 Impactor Inlet when used with our supermicrometer particle sizers.

Vacuum Pumps

- 3032 Flow rates up to 5 L/min, 115 V
- 3032-1 Flow rates up to 5 L/min, 230 V
- 3032-EC Flow rates up to 5 L/min, 230 V (Europe only)
- 3033 Flow rates up to 60 L/min, 115 V (North America only, customers in other parts of the world must contact the factory for model number and power ratings.)

TSI recommends these pumps only for use with specific TSI particle instruments. Please specify voltage requirements.

Process Aerosol Monitor Model 3375



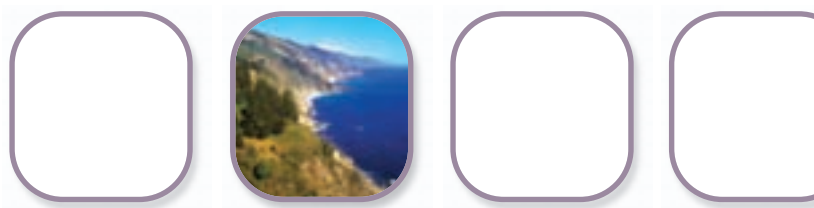
Monitors high-concentration, monodisperse aerosols.

The Process Aerosol Monitor (PAM) measures high-concentration, monodisperse aerosols, like those produced by our Model 3475 Condensation Monodisperse Aerosol Generator (CMAG) or other Sinclair-LaMer-type generators. The PAM is a new type of process instrument. It monitors aerosols on-line, measuring particle size and concentration in real time.

The PAM is a compact, robust device that connects directly to the generator outlet. It validates particle size and concentration and helps confirm that the generator is working properly. It is also suitable for monitoring an aerosol while making adjustments to the generator's operating parameters.

This instrument arrives precalibrated for diethyl-hexyl sebacate (DEHS). It includes an RS-232 serial interface and a dynamic link library (DLL) routine and spreadsheet program. This enables the PAM to communicate with a computer so you can store data on a hard disk—a good idea for calibration purposes!

Please specify voltage requirements. Models 3375 and 3475 are produced in Germany by Topas GmbH. Availability is limited in Europe.



TSI Incorporated serves a global market by investigating, identifying and solving measurement problems. As an industry leader in the design and production of precision instruments, TSI partners with research institutions and customers around the world to set the standard for measurements relating to aerosol science, air flow, health and safety, indoor air quality, fluid dynamics and biohazard detection. With headquarters based in the U.S. and field offices throughout Europe and Asia, TSI has established a worldwide presence in the markets we serve. Every day, our dedicated employees turn research into reality.





Ordering

To order, contact your nearest representative or sales office. If you don't know which office handles your territory, then contact our corporate headquarters. Our staff will answer any questions you may have or they will put you in contact with the appropriate sales office. Contact information can also be found on the TSI web site. When ordering, specify the model number, instrument name, accessory models and names, and voltage requirements.

Customer Service

TSI Customer Service Specialists are available to answer your questions about installation or operation:

US & Canada: 1-800-874-2811

Europe: +49 241 523030

or

www.tsi.com
particle.tsi.com
www.tsiinc.de
www.tsiinc.fr

General Information

TSI Incorporated manufactures innovative instruments for use in industry and research. The particle instruments described in this catalog represent only one of our product families. TSI offers a broad array of sensors and instrumentation systems used in a variety of measurement applications around the globe.

Headquartered in Shoreview, Minnesota, TSI has sales and representative offices all over the world. For more information on TSI particle instruments, use the contact information shown below or visit particle.tsi.com. For information on TSI instruments not discussed in this catalog, go to the main TSI web page at www.tsi.com.

A sincere effort was made to ensure that all information in this catalog was current at the time of publication. However, specifications, features, and availability are subject to change. Please check with your TSI representative for the latest information. Prototype or early instruments are depicted in some photographs. Final products may vary from those pictured. TSI, the TSI logo, Aerodynamic Particle Sizer, APS, Aerosol Instrument Manager, Engine Exhaust Particle Sizer, EEPS, Fast Mobility Particle Sizer, FMPS, Scanning Mobility Particle Sizer, SMPS, DustTRAK and SidePAK, are trademarks of TSI Incorporated. Microsoft and Windows are trademarks of Microsoft Corporation. LabVIEW is a trademark of National Instruments Corporation.

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