NANO WATER-BASED CONDENSATION PARTICLE COUNTER (N-WCPC) MODEL 3788

WORLD'S FASTEST CPC – COUNTING DOWN TO 2.5 NANOMETERS

TSI's N-WCPC Model 3788 is designed for investigators interested in detecting the smallest nanoparticles. This sophisticated particle counter utilizes state-of-the art water-based condensation technology and features the highest activation energy and lowest detectable particle size of the WCPC family. With less than 0.1 second rise time, the Model 3788 is the fastest CPC commercially available and its high sample flow rate provides low diffusion losses and low Poisson noise. The unique combination of fast response time and high sample flow in this instrument enables fast SMPS™ spectrometer size scans. Other important elements include a thermodynamically optimized growth region and enhanced optical and detection design for impressive signal to noise ratios.

Applications

TSI's N-WCPC is suitable for most particle counting applications, but its ability to detect down to 2.5 nanometers, make this WCPC ideally suited for:

+ Particle formation and growth studies
+ Nanotechnology research or process monitoring
+ Inhalation or exposure chamber studies
+ Combustion and engine exhaust studies

Features and Benefits

+ 2.5 nanometer detection
+ Single particle counting to 400,000 particles/cm^3
+ < 100 millisecond rise time response
+ Sheathe flow with high aerosol flow rate for enhanced counting statistics
+ Convenient, VOC-free water as working fluid
+ $1/10^{th}$ second data reporting
+ Built-in SMPS™ spectrometer compatibility
+ USB flash drive data storage option
+ Built in Ethernet capability
+ 6" color touch screen with graphical interface

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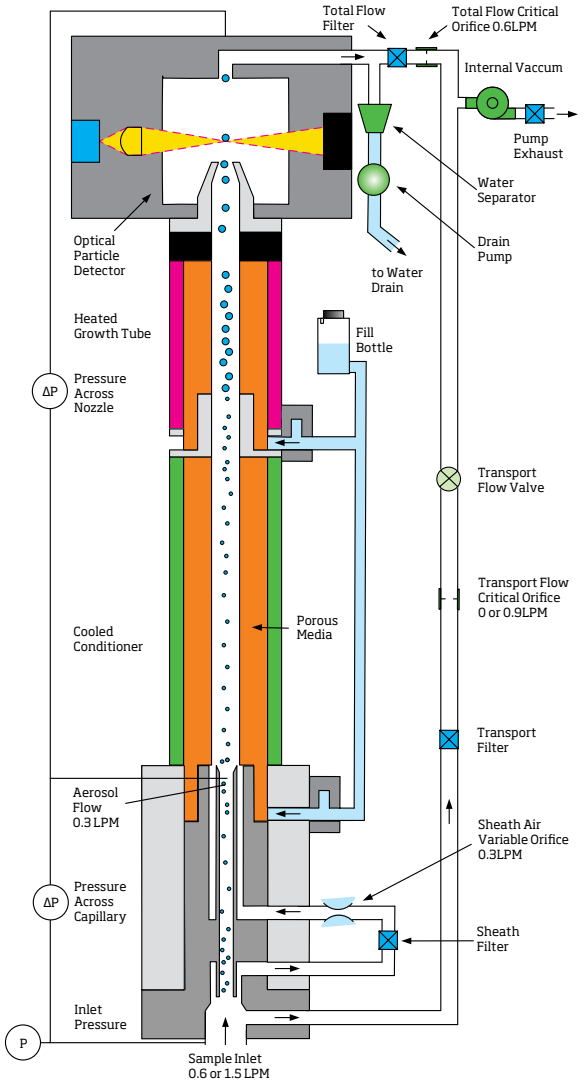
Uniform Particle Growth

The geometry of the growth tube in the N-WCPC was optimized to kinetically limit droplet growth with the intent of preventing particles from growing to different sizes as a function of concentration. This, in addition to changes to the optical design and electronics signal detection components which significantly improve signal to noise ratios enable the N-WCPC to measure accurately at high concentrations without using a photometric mode.



*US Patent Number 6,712,881

Second Generation WCPC Technology

Building from the successful introductory line of WCPCs, the Model 3788 takes WCPC design to the next level combining precision measurements with robust field performance. This instrument delivers a research quality measurement, but its modern, intuitive user interface and flexible data acquisition options make the N-WCPC suitable for a variety of industrial applications as well. Newly engineered from the ground up, the Model 3788 features an air flow scheme utilizing protected critical orifices, a new water handling system with optimized wicking and active water removal, and improved optical and detection design for superior signal detection. A host of on-board instrument diagnostics including a laser reference detector, nozzle pressure transducer, and inlet pressure transducer allow remote, real-time monitoring of instrument status. Other unique features include a removable wick cartridge for easy wick replacement and a field swappable optics module. Manufactured at TSI's ISO 9001 certified facility and calibrated using NIST traceable analytical tools, each Model 3788 that leaves the factory is built for longevity, backed by TSI's commitment to quality, and supported by our worldwide network of committed TSI professionals.

Operation

The N-WCPC utilizes a patented* laminar-flow, water-based condensational growth technique which results in less particle loss and more precise temperature control when compared to mixing CPCs. Particles that are too small to scatter enough light to be detected by conventional optics are grown to a larger size by condensation. In this instrument, an air sample is continuously drawn through the inlet via an internal pump. The aerosol sample flow rate is continuously measured to provide the basis for the concentration calculations. A portion of the flow is used as clean sheath air to surround the aerosol sample. The use of sheath air focuses the particle stream to allow detection of smaller particles and protects the optics from contamination. The aerosol sample is pulled through a cool region saturated with water vapor where its temperature is equilibrated. The sample then passes to a growth section with heated, wetted walls where the small cool particles in the flow stream act as nuclei for condensation and grow into micron sized droplets. The droplets are passed by a laser and the particle pulses are detected and counted. The N-WCPC counts single particles with continuous, live-time coincidence correction up to 400,000 particles/cm^3.

CPC Software and SMPS™ Spectrometer Capability

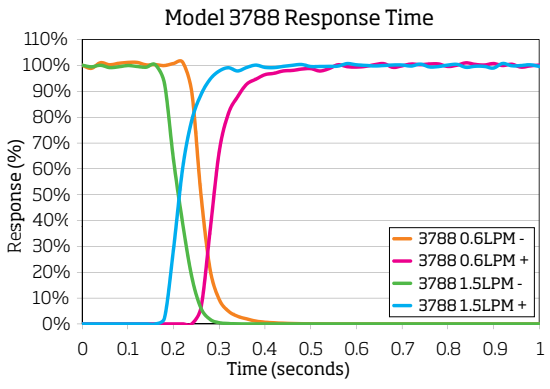
The N-WCPC is supplied with Aerosol Instrument Manager® Software for CPCs. This Microsoft® Windows® 7, 64-bit compatible software controls instrument operation and provides file management capabilities. Live data graphs and data tables can be viewed from the PC. The data can be weighted by any moment of the number concentration including surface area and mass, and the software automatically calculates statistics on every data set. The Nano-WCPC is compatible for use in TSI SMPS™ spectrometers, which collectively, are capable of providing size distributions from 0.0025 to 1 µm.

Pulse Height Analyzer

The Nano WCPC Model 3788 utilizes a pulse height analyzer to monitor instrument health and supersaturation state as a safeguard for measurement accuracy. In well functioning condensation particle counters the particles all grow to a similar size and the analog pulses all have a similar height. The Model 3788 monitors and displays the amplitude of the analog pulse height on the status screen of the instrument. A warning will trigger if the pulse height amplitude falls below a threshold value.

Nano-WCPC Response Time

The response of the N-WCPC to a step change in concentration was measured and plotted below. The ~250 millisecond time to a 95% response in concentration in high flow rate mode includes a flow rate based pipe delay. Under normal operation with constant flow, the traditional rise time (10-90%) is < 100 milliseconds. The time constant (τ) of the Model 3788 is ~43 milliseconds.

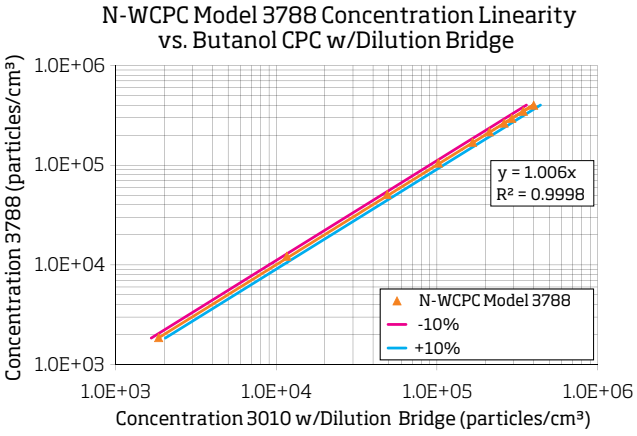


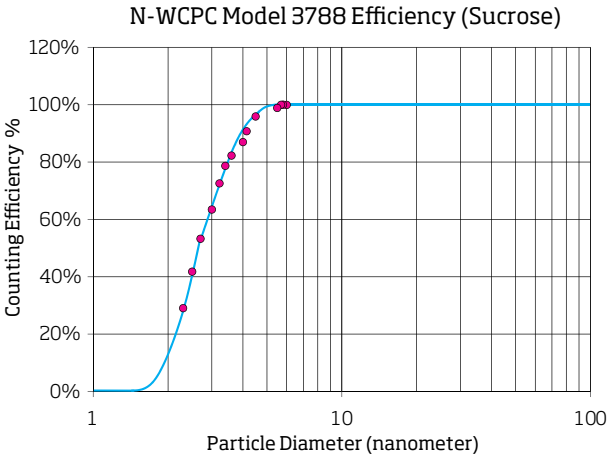
Extended Single Particle Counting

The Model 3788 employs optimized optics design, more controlled particle growth and advanced electronics processing to extend the single particle counting range of condensation particle counters. Single particle counting gives greater data consistency and is in principle, a more fundamental measurement than other techniques used to increase concentration ranges in CPCs.

Efficiency and Concentration Linearity

The minimum detectable particle size efficiency curve was measured using sucrose aerosol generated by a Electrospray Model 3480 and size classified using the Electrostatic Classifier Model 3080. Concentration comparisons were made on the N-WCPC versus both a butanol CPC with a dilution bridge and an electrometer using classified salt aerosol showing excellent agreement.





SPECIFICATIONS

NANO WATER-BASED CONDENSATION PARTICLE COUNTER (N-WCPC) MODEL 3788

Particle Size Range

Min. Detectable Particle ($D50_0$)	2.5 nm, verified with DMA-classified sucrose
Max. Detectable Particle	> 3 µm

Particle Concentration Range

Single Particle Counting	0 to 400,000 particles/cm^3, with continuous live-time coincidence correction

Particle Concentration Accuracy
±10% to 400,000 particles/cm^3

Flow

High Flow Rate	1.5 ±0.15 L/min
Low Inlet Flow Rate	0.6 ±0.06 L/min
Aerosol Flow Rate	0.3 ±0.03 L/min
Sheath Flow Rate	0.3 ±0.03 L/min

Response Time (95% response to concentration step change)

High Flow (1.5 LPM)	~ 250 milliseconds
Low Flow (0.6 LPM)	~ 400 milliseconds
Rise Time (10 - 90%)	< 100 milliseconds
Time Constant (τ)	~ 43 milliseconds

False Background Counts
< 0.02 particles/cm3, 12-hour average Dew point < 30°C (i.e. < 35°C @ 75% RH)

Aerosol Medium
Air only

Environmental Operating Conditions

Ambient Temperature Range	10 to 35° C (50 to 95° F) Dew point < 30° C (i.e. < 35° C @ 75% RH)
Ambient Humidity Range	0 to 90% RH, non condensing

Inlet Pressure Operation (Absolute)
75 to 110 kPa (0.75 to 1.1 atm)

Inlet Pressure (Gauge)
0 to -5 kPa (-20" H_2O)

Condensing Liquid
Water (distilled (<6 ppm) or HPLC water; tap water must not be used)

Water System
External 1L bottle used in recycle mode for up to 30 days of continuous operation

Water Consumption
<33 ml/day

Vacuum
Internal vacuum pump

Outputs

Interfaces	RS-232, USB, Ethernet, or USB Flash Drive
Digital Display	6" color touch screen interface
Analog Output	BNC connector, 0 to 10V proportional to concentration (log scaling)
Digital Output	Data download using USB or RS-232 serial interface
Protocol	Command set based on ASCII characters

Power Requirements
100 to 240 VAC, 50/60 Hz, 200 W maximum

Physical Features

Dimensions (H x W x D)	30.5 x 16 x 36 cm (12 x 6.25 x 14.25 in.) not including water supply bracket
Weight	8.2 kg (18 lbs)

Software
TSI Aerosol Instrument Manager® software for CPC included. TSI SMPS™ spectrometer software compatible

Calibration
Recommended annually

TO ORDER

Nano Water-based Condensation Particle Counter

Specify	Description
3788	Nano Water-based Condensation Particle Counter with TSI Aerosol Instrument Manager® Software for CPC

Optional Accessories

Specify	Description
3031200	Environmental Sampling System (includes a standard PM10 inlet, a PM1 cyclone, a flow splitter an a Nafion® dryer)
1188001	Model 3788 maintenance kit
376060	Particle Size Selector with 11 screens: adjusts 3788 lower end efficiency cut-point between ~0.01 and ~0.2 µm
376061	Additional screens for Particle Size Selector, set of 12 adjusts Model 3788 cut-point up to ~0.45 µm

Specifications reflect typical performance and are subject to change without notice. The technique of using a Condensation Particle Counter with diffusion screens to select specific size ranges is covered in U.S. Patent Number 5,072,626.

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TSI Incorporated - Visit our website **www.tsi.com** for more information.

USA	**Tel:** +1 800 874 2811	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8251 6588
France	**Tel:** +33 4 91 11 87 64	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

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Kenelec Scientific Pty Ltd
1300 73 22 33
sales@kenelec.com.au
www.kenelec.com.au

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