ENGINE EXHAUST CONDENSATION PARTICLE COUNTER MODEL 3790A



Condensation particle counters (CPCs), like the Engine Exhaust Condensation Particle Counter (EECPC) Model 3790A, accurately measure PN concentration of exhaust emissions. In fact, the GRPE Particle Measurement Program (PMP) completed the light-duty, inter-laboratory correlation exercise (LD ILCE) and 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 included in Euro 5 Regulation 83 and Euro 6 Regulation 49.

The Engine Exhaust Condensation Particle Counter (EECPC) Model 3790A is fully compliant for light-duty and heavy-duty vehicle certification in accordance with all Euro 5 Regulation 83 and Euro Regulation 49 requirements. Built upon the proven rugged, reliable, and highly repeatable performance of the CPC Model 3010D, the EECPC Model 3790A incorporates a wide assortment of design improvements and features such as anti-spill, anti-flooding design, condensate removal system, adjustable, internal calibration factor, removable saturator for ease of maintenance, built-in microprocessor with USB, RS-232 and Ethernet communication interfaces, touch-panel membrane keys and a display for setting-up instrument operating parameters, viewing particle number concentration and count data, interrogating instrument status, and data storage capabilities.

Features and Benefits

+ Meets the lower particle size detection limit at the defined D_{50} and D_{90} counting efficiencies
+ Achieves a linear response to particle concentration from 1 to 10,000 particles/cm^3 with $R^2 \geq 0.97$
+ Achieves a counting accuracy of ±10% against a traceable standard
+ Operates under full flow conditions using single particle counting
+ Incorporates continuous, live-time coincidence correction for maximum accuracy
+ Calibrated in full compliance with proposed requirements
+ Achieves readability of 0.1 particles/cm^3
+ Internal pulse height monitor to indicate measurement quality
+ 10 Hz data rate for model analysis

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Software

Every Model 3790A is supplied with Aerosol Instrument Manager® software designed for use with Microsoft® Windows® operating systems. The TSI Aerosol Instrument Manager software is used for instrument control and provides data management and export capabilities as well as several choices for data display.

Rotating Disk Diluter & Thermal Conditioner Accessories for PMP Model 379020 and 379030 Combination

ECE Regulations 83 and 49 mandate that only the number concentrations of solid particles are measured. Therefore, nucleation mode particles (i.e., nanoparticles) formed by the condensation of volatile compounds found in engine exhaust must be suppressed or eliminated. As a result, the proposed regulations specify a particle sampling and measurement system* shown in Figure 1.

The combination of the Rotating Disk Thermodiluter Models 379020 and Thermal Conditioner Air Supply 379030 is a "thermodiluter" that complies with all proposed regulatory requirements, including:

+ Achieves >99% removal of C_{40} (tetracontane) particles
+ Achieves solid particle penetration at 30 nm, 50 nm and 100 nm particle diameters as specified
+ Capable of diluting a sample to achieve a particle number concentration less than 10,000 particles/cm^3
+ Contains an evaporation tube that eliminates volatile nanoparticle formation

The Rotating Disk Thermodiluter features a separate exhaust probe and control unit that dilutes the sample up to 1,000:1 and thermally conditions it at 150°C. The Thermal Conditioner Air Supply heats the sample up to 400°C in the evaporation tube to eliminate nanoparticle formation and then further dilutes and cools the sample so that solid PN concentration can be accurately measured by the Model 3790A EECPC. Together, the Models 3790A, 379020 and 379030 (Figure 2) fulfill the proposed solid PN sampling and measurement requirements shown in Figure 1.

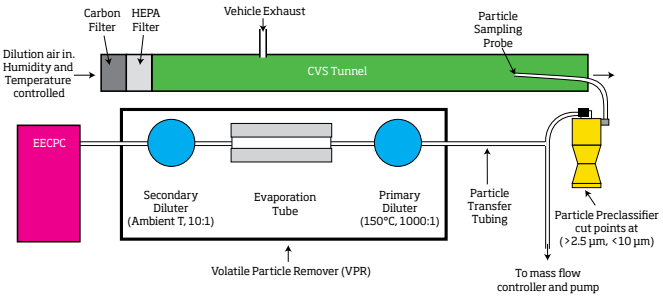
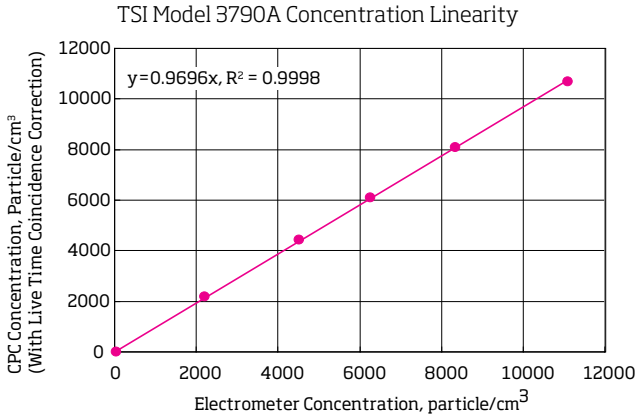


Figure 1. Proposed Regulation 83 Particle Sampling and Measurement System



Figure 2. Model 3790A EECPC shown with Models 379020 Rotating Disk Thermodiluter and 379030 Thermal Conditioner Air Supply

*Based on proposed ECE Regulations 83 and 49 working draft documents. The proposed regulations specify certain measurement criteria and procedures. Please refer to the proposed regulations for further details.



Specifications
Model 379020 and 379030 Combination

Sample Inlet Conditioner

Flow Rate	Approx. 1.0 L/min
Differential Pressure†	-100 to +150 hPa
Raw Gas Temperature Range	0 to 200°C, noncondensing gas environment

Primary Diluter

Exhaust Probe	Heated rotating disk diluter
Temperature Settings	OFF, 80, 120, or 150°C
Nominal Dilution Ranges	
10-cavity Disk	15:1 to 300:1
8-cavity Disk	150:1 to 3,000:1
Dilution Accuracy	±10% using the calibration factors supplied with each disk
Connections to Control Unit	
Pneumatic	Flexible, metal protective tube containing two silicon and one conductive plastic tube (3 m length)
Electrical	Multi-pole electrical cable housed in a flexible, metal protective tube (3 m length)
Dimensions (H x W x D)	180 mm × 280 mm × 90 mm (7 in. × 11 in. × 3.5 in.)
Weight	Approx. 2.5 kg (5.5 lbs)

Evaporation Tube

Temperature Range	Ambient to 400°C (selectable)
Temperature Measurement	±2°C
Temperature Control	±3°C

Secondary Diluter

Dilution Range	1:1 to 11:1
Air Supply Flow	0 to 15 L/min air supply with accuracy of 3% of set value +0.1 L/min
Dilution Range Settings	Adjustable via front panel 10-turn potentiometer or via analog input (0 to 10 V)

Measurement Channel Flow Rate (to instrument)

Up to 16.5 L/min; Excess air leaves secondary diluter via dedicated excess air channel that includes filter and mass flow meter

Programming Interface

Functions can be controlled by digital (5 V) and analog (0 to 10 V) signals via 25-pin D-sub female connector on rear panel

Control Unit

Dimensions (H x W x D)	146 mm × 485 mm × 530 mm (5.75 in. × 19 in. × 20.9 in.)
Weight	17.5 kg (38.5 lbs)
Power Requirements	100 to 240 VAC, 50/60 Hz, 450W

†Between raw gas channel and ambient conditions

TO ORDER

Condensation Particle Counter

Specify	Description
3790A	Engine Exhaust Condensation Particle Counter with TSI Aerosol Instrument Manager software

Accessories

Specify	Description
3032	Vacuum Pump, 115 V
3032-1	Vacuum Pump, 230V/50Hz
3032-EC	Vacuum Pump, 230V (Europe only)
1031515	Maintenance Kit (includes 2 micropump filters, 3 butanol fill/drain filters, and 2 saturator wicks)
379020	Rotating Disk Thermodiluter
379030	Thermal Conditioner Air Supply

Accessories must be ordered separately



SPECIFICATIONS

ENGINE EXHAUST CONDENSATION PARTICLE COUNTER MODEL 3790A

Lower particle size detection characteristics

D_{50} efficiency	50% ± 12% at 23 nm
D_{90} efficiency	> 90% at 41 nm

Max. Detectable Particle
>3 µm

Particle Concentration Range
Single particle counting from 0 to 10,000 particles/cm^3 with continuous, live-time coincidence correction

Concentration Accuracy
±10% compared to standard

Calibration Method
Calibrated against aerosol electrometer and electrostatically classified particles; Unit incorporates an adjustable, internal calibration factor

Concentration Linearity
Linear response from 1 to 10,000 particles/cm^3 with correlation coefficient (R^2) ≥ 0.97

Aerosol Sample

Flow Rate	1.0 L/min (0.035 cfm); NIST traceable
Flow Control	Volumetric flow using critical orifice; differential pressure across critical orifice is monitored; external vacuum required (not included)

Response Time
<5 sec for 95% response to concentration step change

Averaging Interval
1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 seconds via front panel; more selections available using software

False Background Counts
<0.001 particle/cm^3

Environmental Operating Conditions (ambient)

Temperature	10 to 35°C
Humidity	0 to 90% RH, non-condensing
Pressure	75 to 105 kPa (0.75 to 1.05 atm.)

Working Fluid
Reagent-grade n-butyl alcohol (not included)

Condensate Removal
All condensate is collected and removed automatically by a constant-flow-rate micropump

Communications

Protocol	Command set based on ASCII
Interfaces	
RS-232	9-pin, D-sub connector
USB	Type B connector, USB 2.0 compatible at 12 MB
Ethernet	8-wire RJ-45 jack, 10/100 BASE-T, TCP/IP

Input/Output

Analog Output	BNC connector, 0 to 10V proportional to concentration (configurable)
Pulse Output	BNC connector, TTL level pulse, 350 nanosec width (nominal)
Analog Input	Two BNC connectors, 0 to 10V for logging data from external sensors

Data Logging and Storage
SD/MMC flash memory card

Software
Supplied with Aerosol Instrument Manager® software, CPC module

Calibration Check
Recommended annually

Required Utilities

Power	100 to 240 VAC, 50/60 Hz, 210 W max
Vacuum Source	60 kPa (18 in. Hg) min. gauge

Front Panel Features
Aerosol sample inlet, particle and status indicator lights, 2-line LCD display, touch-panel membrane key buttons

Dimensions (L x W x H)
260 mm × 180 mm × 250 mm (10 in. × 7 in. × 10 in.)

Weight
5.5 kg (12 lbs)

Date Rate
10 Hz

Specifications are subject to change without notice.

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