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Nanotechnology - Measurement of nanoparticles over a wide temperature range - Condensation particle counting method

纳米技术 宽温域纳米颗粒测量 凝结核粒子计数法

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7.1 Pre-measurement inspection

7.1.1 Measurement Conditions When conducting laboratory or field atmospheric tests on the performance characteristics of WTCPC, the sampling gas temperature can be within a wide temperature range of -10°C to 300°C. In harsh environments, to prevent the entry of large particles and water droplets, a waterproof cap and a large particle separation device (such as a cyclone separator) should be installed at the instrument inlet. (Cutter or particle impactor, etc.). The concentration of the sample to be tested should be <=50,000 particles/mL. If the sample concentration is higher than this, the sample temperature should be kept constant. Under varying conditions, dilute to this range. Depending on the measured particle number concentration, an ejector diluter or a rotating disc diluter can be used. Release vessel.

7.1.2 Inspection of measuring instruments

7.1.2.1 Condensation nucleus particle counter check Check the working fluid level using the viewing window or liquid level sensor. Preheat the unit until the number of aerosol particles in the background air stabilizes. (Measurement begins when fluctuation error is < 10% within 1 minute). The condensation section, optical particle counter, and saturation section should be set according to instrument requirements. Check if the instrument flow rate is within the required range. Perform the test as follows:

a) Turn on WTCPC, and after the instrument has warmed up, allow air to pass through to the atmosphere. Once the readings stabilize, connect a high-efficiency air filter to the instrument inlet. (HEPA), wait for the instrument reading to drop to 0 and stabilize;

b) Record the number of non-zero fluctuations in the WTCPC panel values within 1 minute, and check whether the final result meets the requirements, including the fluctuation rate. 5 times/min, with each jump not exceeding 20 beats/mL.

7.1.2.2 Carbon Dioxide Analyzer Inspection Check if the carbon dioxide analyzer can measure CO_2 gas within its measurement range. Turn on the instrument and allow it to warm up until the background air concentration is measured. Measurements were started after the CO_2 value stabilized (fluctuation error < 2% within 1 minute).

7.1.3 Sample Gas Collection and Gas Phase Piping Leakage Inspection Check for leaks in the sample gas collection and gas phase piping sections; the leakage flow rate should be less than

0.4 L/min. The inspection setup is shown in Figure 3. The method is as follows:

7.1.4 Check the cleanliness of the sample gas collection section and gas phase pipeline. Check the cleanliness of the sample gas collection section and the gas phase pipeline. The inspection method is as follows:

a) Close pressure control valve P1 and check valve 1 to isolate the gas phase line from the measurement section;

b) Isolate the gas phase line from the probe and connect the sampling tube to the zero gas source;

c) Heat the system to the operating temperature required to perform the measurement;

d) Operate the sample gas flow pump and set the flow rate to the rate used during the emission test;

7.1.5 Inspect the cleanliness and for leaks of the transport components. Check the cleanliness and leakage of the transport section. The average particulate matter concentration should be less than

2.0 particles/mL within 30 seconds. The inspection method is as follows:

a) Close the one-way valve 1 to allow the diluent gas to pass through the high-efficiency air filter before entering the diluent 1;

7.2 Measurement Implementation

7.2.1 Sampling To check for sampling flow rate errors, connect a standard flow meter to the instrument's inlet, power on the instrument, start the sampling pump, and the instrument will enter normal operating condition. Then, adjust the instrument flow rate to its set value. Measure the flow rate once, and then measure it again every 10 minutes, for a total of no less than [number missing] measurements. The sampling flow rate error was calculated three times according to formula (1).

7.2.2 Counting Measurement Counting begins after the sample stabilizes. Check the gas analyzer for zero drift every hour, and if any change exceeds the full-scale value... If 2% of the test results are lost, that section should be rerun. The single counting time should not be less than 60 seconds, the measurement frequency should not be less than

1 Hz, and the number of measurements should be... The number of measurements should not be less than three, and the reported value should be the average of the measurements. Record the measurement data according to the requirements of Appendix C. If the measurement is affected by environmental factors... In specific scenarios, the particulate matter number concentration in the environment should be obtained before and after the test, and the reported value should be the average of the two measurements. Mean.

7.3 Post-measurement inspection

7.3.1 Zero drift check of gas analyzer After the measurement is completed, the zero drift of the gas analyzer should be checked again and the measurement data should be corrected.

7.3.2 Sample Gas Sampling Partial Backwashing The sample gas collection section should be backwashed with diluent gas for at least 5 minutes to prevent residual gas from remaining in the sampling probe and tubing. Residual material. The backwashing configuration for the sample gas collection section is shown in Figure

4.The operating steps are as follows:

a) Close pressure control valve P1 and check valve 1 to isolate the gas line from the particle measurement section;

b) Disconnect all components of the gas phase pipeline;

c) Introduce the dilution gas from the gas phase line.

8 Measurement uncertainty

8.1 Uncertainty introduced by sampling tube loss Using aerosol samples with a particle size distribution consistent with or similar to the measured gas sample as the measurement object, a calibrated condensation nucleus particle counter is used. (The relative standard uncertainty of the counting efficiency calibration is ueta) Measure the particle concentration at the inlet and outlet of the sampling tube, denoted as Cin and Cout respectively. By comparing the above measurement results, the sampling tube loss can be evaluated. Based on the above evaluation method, the relative standard introduced for sampling tube loss is not... The degree of certainty ul can be calculated from the results of two measurements using formula (2).

8.2 Uncertainty introduced by sampling flow rate The uncertainty introduced by the sampling flow rate can be evaluated using the following two methods.

a) As described in 7.3.1, the relative error of WTCPC sampling flow rate in the range of

0.3 L/min to 3 L/min is within ±10%. Because The relative standard uncertainty uQs introduced by this sampling flow rate can be calculated using formula (3).

b) As described in 7.3.1, the sampled flow rate of WTCPC was calibrated using a standard flow meter, and the average value of the three calibration results was used. The standard deviations are Qp and SDp, respectively. The relative standard uncertainty uQs of the standard flowmeter can be obtained from the calibration process. Therefore... The relative standard uncertainty uQ introduced by the sampling flow calibration can be calculated by formula (4).

8.3 Uncertainty introduced by the counting efficiency of the condensation nucleus particle counter The relative uncertainty ueta of the counting efficiency calibration of the condensed nucleus particle counter used can be obtained from its calibration process.

8.4 Uncertainty introduced by measurement repeatability The particle number concentration was measured n times according to the method in 7.2.2.The average value and standard deviation of the measurement results are Cpn and, respectively. SDpn. Therefore, the relative standard uncertainty uA introduced by measurement repeatability can be calculated by formula (5).

8.5 Combined relative standard uncertainty and relative expanded uncertainty of measurement results The combined relative standard uncertainty of the measurement results can be calculated according to formula (6).

9.Measurement Report The measurement report should include, but is not limited to, the following information.

a) Report number;

b) Sample name, submitting organization, and submission date;

c) Information related to sample identification;

d) Laboratory and analysis time;

e) This document number;