

Australian/New Zealand Standard™

AS/NZS 3580.9.7:2009

Methods for sampling and analysis of ambient air

Method 9.7: Determination of suspended particulate matter—Dichotomous sampler (PM₁₀, coarse PM and PM_{2.5})—Gravimetric method

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EV-007, Methods for Examination of Air as an Australian/New Zealand Standard to supersede AS 3580.9.7—1990, *Methods for sampling and analysis of ambient air, Method 9.7: Determination of suspended particulate matter—PM₁₀ dichotomous sampler—Gravimetric method*.

The objective of this Standard is to provide regulatory and testing bodies with a standard method for determining suspended particulate matter with equivalent aerodynamic diameters of less than 10 µm and 2.5 µm, utilizing a dichotomous sampler and size selective inlet.

The procedure described in this Standard involves batch sampling and the gravimetric determination of coarse PM, PM_{2.5} and PM₁₀.

The term ‘normative’ has been used in this Standard to define the application of the appendix to which it applies. A ‘normative’ appendix is an integral part of a Standard.

FOREWORD

Suspended particulate matter measured by this method includes particles with equivalent aerodynamic diameters (EAD) less than 10 µm and 2.5 µm, as passed by a size selective inlet and virtual impactor (PM₁₀ and PM_{2.5}).

Particles with EAD of 10 µm and less are classified as respirable and hence may affect health. Particles larger than 10 µm generally have nuisance and aesthetic impacts only. PM₁₀ emission sources include industrial processes, fuel combustion, burning of vegetation, incineration and natural causes such as wind blown dust and salt laden air.

PM_{2.5} has been statistically associated with certain human health end points, including daily mortality, hospital admissions and exacerbation of asthma. PM_{2.5} emission sources include industrial processes, fuel combustion, burning of vegetation, incineration and natural causes such as wind blown dust and salt laden air. Combustion processes tend to contribute more PM_{2.5} than non-combustion sources. Important anthropogenic sources include domestic wood heaters and motor vehicles (especially diesel fuelled vehicles).

METHOD

1 SCOPE

This Standard sets out a gravimetric procedure for the concurrent determination of the PM₁₀ and PM_{2.5} fractions of suspended particulate matter in ambient air collected in a dichotomous sampler. The method provides a measure of the mean concentration of PM₁₀ over the sampling period of the two size fractions, viz. the fine fraction (less than approximately 2.5 µm) and the coarse fraction (2.5 µm to 10 µm). A procedure for assessing the performance of dichotomous samplers so that they comply with the sampling requirements of this method, is described in Appendix A.

NOTE: Sampling is normally of 24 h duration to average out diurnal variations. Provided that the mass of the filter is determined under carefully controlled laboratory conditions, mean concentrations of 5 µg/m³ (1.67 L/min sample flow rate) or 1 µg/m³ (15 L/min sample flow rate) and greater may be determined, based on a 24 h sampling period.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- 2162 Verification and use of volumetric apparatus
- 2162.1 Part 1: General—Volumetric glassware

AS/NZS

- 3580 Methods for sampling and analysis of ambient air
- 3580.1.1 Part 1.1: Guide for the siting of sampling units

- 3760 In-service safety inspection and testing of electrical equipment

AS ISO/IEC

- 17025 General requirements for the competence of testing and calibration laboratories

ISO

- Guide to the expression of uncertainty in measurement (ISO GUM)

EN

- 12341 Air quality. Determination of the PM₁₀ fraction of suspended particulate matter. Reference method and field test procedure to demonstrate reference equivalence of measurement methods

US EPA

- US Code of Federal Regulations—Environmental Protection Agency Vol 62, No. 138, July 18, 1997 & Vol 64, No.77, April 22, 1999, 40 CFR, Part 50, Appendix L

- US Code of Federal Regulations—Environmental Protection Agency 40 CFR, Chapter I, Part 50, Appendix J and Parts 53.4 to 53.43 inclusive

NATA

- Technical Note 8—In-situ calibration of barometers

- Technical Note 13—Users check of balance calibration

- Technical Note 19—Liquid-in-glass thermometers—Selection, use and calibration checks

3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

3.1 Coarse fraction

The coarse fraction consists of all particles having an equivalent aerodynamic diameter (EAD) between 2.5 μm and 10 μm that, together with the fine particle fraction, have passed through the size selective inlet.

3.2 Coarse PM

Atmospheric suspended particulate matter having an EAD between 2.5 μm and 10 μm .

3.3 Equivalent aerodynamic diameter (EAD)

The diameter of a spherical particle of unit density (1 g/cm^3) which exhibits the same aerodynamic behaviour as the particle in question.

3.4 Field blank filter

A filter not used for sampling, which has been taken into the field. The filter is handled as a sample filter, including placing it in the sampler filter holder, and removing it, except the sampler is not in operation during this time. A field blank filter is used to assess the effect of field conditions, transport conditions and field operator technique on the weighing procedure.

3.5 Fine fraction

The $\text{PM}_{2.5}$ fraction of the PM_{10} passing through the size selective inlet.

3.6 Laboratory blank filter

A filter not used for sampling, which remains in the laboratory. A laboratory blank filter is used to assess the effect of laboratory conditions and balance operator technique on the weighing procedure.

3.7 PM_{10}

Atmospheric suspended particulate matter having an EAD of less than approximately 10 μm , which is passed by a size selective inlet having performance characteristics as defined in US Code of Federal Regulations: Title 40, Chapter 1, Part 50, Appendix J or equivalent.

NOTE: One of the performance characteristics referred to is that there is a 50% collection efficiency of particles of $10 \pm 0.5 \mu\text{m}$ EAD.

3.8 $\text{PM}_{2.5}$

Atmospheric suspended particulate matter having an EAD of less than approximately 2.5 μm , which is passed by a size classifier having performance characteristics as defined in United States Code of Federal Regulations: Title 40, Parts 53.40 to 53.43.

NOTE: One of the performance characteristics referred to is that there is a 50% collection efficiency of particles of $2.5 \pm 0.2 \mu\text{m}$ EAD.

3.9 U_{95}

A measurement uncertainty at a confidence interval of 95% according to ISO GUM.

4 PRINCIPLE

Ambient air is drawn at a constant flow rate through a size-selective inlet. The resultant PM_{10} fraction is split into fine and coarse fractions which are collected separately on pre-weighed filters in the sampling apparatus. Each sample filter is weighed before and after sampling to determine the mass of the collected particles.

5 APPARATUS

5.1 Dichotomous sampler

Consists of a two stage sizing device; the first stage (size selective inlet) allows only the PM₁₀ particles to pass through to the second stage (virtual impactor). The size selective inlet may be an impaction plate(s) or sharp cut cyclone. In the second stage, the PM₁₀ is fractionated into coarse and fine fractions by splitting the flow into two unequal streams. The total air flow of 16.7 L/min is split into a 1.7 L/min coarse fraction flow and a 15 L/min fine fraction flow. The equipment arrangement allows the coarse fraction to follow the straight path of the minor flow and the fine fraction to follow both the minor and major flow paths.

The equipment generally consists of a control module and a sampling module. The sampling module is illustrated in Figure 1. The principle of operation of the virtual impactor is shown in Figure 2.

A timer capable of controlling the operation of the sampler to within 1% of the selected time period may be used. A seven-day timer is useful for operating the sampler on preset days in unattended locations.

The performance of the dichotomous sampler shall comply with US EPA requirements described in US Code of Federal Regulations, Title 40, Parts 53.40 to 53.43 inclusive, or attain a performance equivalent to a US EPA reference dichotomous sampler, sited and tested under the conditions described in Appendix A.

5.2 Filters

The filters selected should be 37 mm or 47 mm diameter PTFE, with or without a support ring. Filter pore size shall be a maximum of 2 µm, with a specified collection efficiency of at least 99.95% for particles of 0.3 µm EAD. The filters shall be free from pinholes and other defects (see Clause 5.6).

NOTE: Where the collected sample is to be used for other determinant(s), the filter should be selected to ensure minimum interference to such determinant(s). Preferred filters are 37 mm or 47 mm diameter PTFE coated glass fibre, PTFE (with support ring), PVC or polycarbonate filters.

5.3 Microbalance

An analytical balance with a minimum resolution of 1 µg.

Single point checks shall be conducted on a monthly basis, repeatability checks on a six-monthly basis, and a full calibration every three years. (NATA Technical Note 13)

As well, a test weight within the expected range of measurement shall be used.

5.4 Static eliminator

An alpha particle source (Americium 241 of 4×10^5 Bq activity, or Polonium 210 of 2×10^7 Bq activity), or a high voltage static elimination unit, is required to neutralize any static charge on the filters prior to weighing.

The alpha particle source shall be renewed when found to be ineffective (typically 1 to 2 years).

NOTE: A licence from your national radiation laboratory may be required to operate and dispose of an alpha particle source.

5.5 Flow meter

A traceable reference standard flow measuring device (e.g. calibrated bubble meter or calibrated gas meter) with a U₉₅ of ±2% at the operating flow rate.

The swept volume for a bubble meter shall be verified using the gravimetric method in which capacity is determined by weighing the quantity of distilled or demineralized water as in AS 2162.1.

A traceable transfer standard flow measuring device (e.g. electronic piston meter, electronic bubble meter or flow meter), with a U_{95} of $\pm 2\%$ at the operating flow rate, may be used for field applications. The transfer standard device shall be calibrated against a reference standard device on a two-yearly basis.

5.6 Light-table

A light-table to check filters for pinholes or other defects.

5.7 Thermometer

A traceable thermometer with a U_{95} of $\pm 0.5^\circ\text{C}$ and a resolution of 0.1°C . The thermometer shall be checked against a reference standard thermometer at 0°C (ice point), or at one point in the working range, on a six-monthly basis (NATA Technical Note 19).

5.8 Timing device

A stopwatch or other timing device, capable of measuring elapsed time (typically greater than or equal to a period of 15 seconds), with a U_{95} of $\pm 1\%$ and a resolution of 0.1 second. The timing device shall be checked against the recorded time signal, over a minimum period of one hour, on a six-monthly basis.

5.9 Barometer

A traceable barometer with a U_{95} of ± 0.5 kPa.

The barometer shall be checked on a six-monthly basis, at one point against barometric pressure measured at an appropriately located meteorological station (NATA Technical Note 8). Alternatively, barometric pressure may be determined from measurements taken at an appropriately located meteorological station, with the pressure corrected for differences in elevation between the sampling site and the meteorological station (NATA Technical Note 8).

5.10 Relative humidity and temperature measuring device

A device for measuring and recording the relative humidity (U_{95} of $\pm 5\%$) and temperature (U_{95} of $\pm 1^\circ\text{C}$) in the filter conditioning environment, at intervals not exceeding 15 minutes. The relative humidity device shall be checked on a six-monthly basis, at one point. The temperature device shall be checked on a six-monthly basis, at one point.

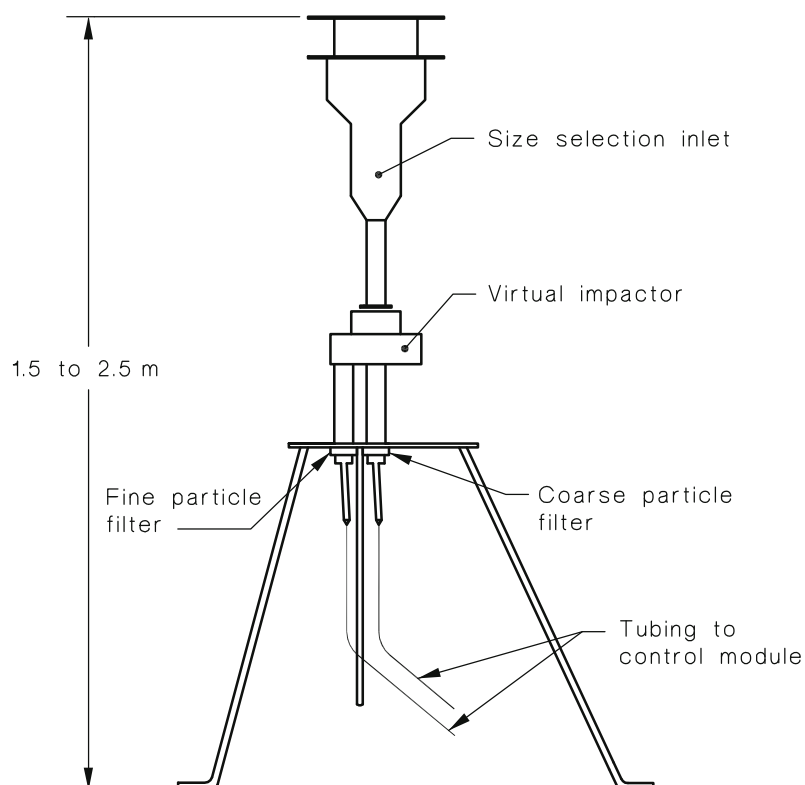


FIGURE 1 SAMPLING MODULE

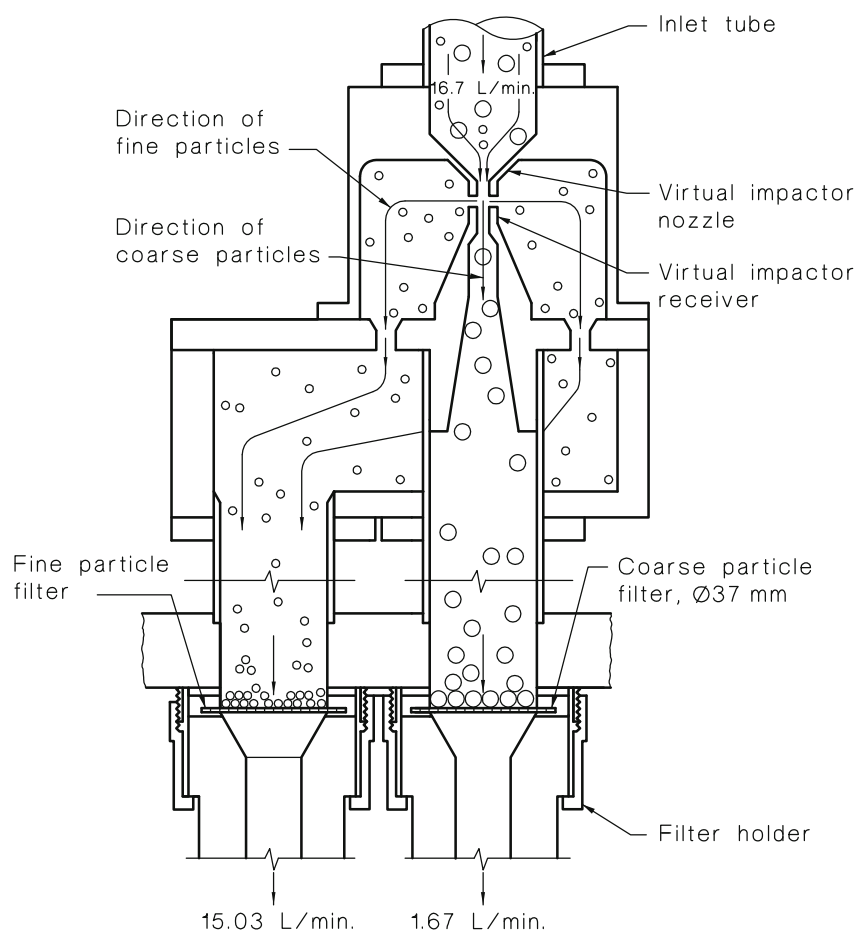


FIGURE 2 VIRTUAL IMPACTOR—SCHEMATIC DIAGRAM OF SEPARATION

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