Designation: D 2009 – 65 (Reapproved 1990)

An American National Standard

Standard Practice for Collection by Filtration and Determination of Mass, Number, and Optical Sizing of Atmospheric Particulates[1]

This standard is issued under the fixed designation D 2009; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This practice has been approved for use by agencies of the Department of Defense and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This recommended practice covers the sample collection of particulate matter from an atmosphere by filtration and for measurement of mass amount, particle size, and particle size distribution of the collected material. Variations in the recommended practice permit sampling to meet a number of widely different assay needs. Although especially applicable to collection of solid particles, the filter method may be used also to collect liquid particles if droplet size need not be determined.

2. Referenced Documents

2.1 *ASTM Standards:*

D 1356 Definitions of Terms Relating to Atmospheric Sampling and Analysis[2]

D 1357 Practice for Planning the Sampling of the Ambient Atmosphere[2]

D 1704 Test Method for Particulate Matter in the Atmosphere (Optical Density of Filtered Deposit)[2]

3. Definitions

3.1 For definitions of terms used in this recommended practice, refer to Definitions D 1356.

4. Summary of Recommended Practice

4.1 A measured and representative sample of the atmosphere under investigation is drawn through a filter medium selected to arrest and permit measurement of the particles that are to be studied. For most purposes, the exposed filter medium is removed from the sampling device and appropriate examination methods then applied to the collected matter. This recommended practice provides for determination of mass loading, particle concentration, particle size and size distribution, and particle inspection. Chemical composition, radioactivity, and other characteristics of the particles may be determined by additional methods not included in this recommended practice. Studies by phase microscopy, electron microscopy, or other techniques also may be made on the collected material.

5. Apparatus

5.1 *Sample Collector*—Figure 1 shows, schematically, a typical arrangement of apparatus parts in a filter sampling system. These include a sampling nozzle, filter holder, filter medium, flow-measuring device, flow-inducing device, and means for regulating the flow of the sample air or gas.

5.1.1 It is important that the filter be upstream from the rest of the apparatus so that any dirt in the system, manometer liquid, or pump oil will not be carried accidentally into the filter. The filter should be as close as possible to the sampling point, and any sampling lines must be perfectly clean. When sampling from a moving stream, as in a duct or stack, careful attention must be given to the shape and position of the nozzle. Recognized principles of stream sampling must be used, otherwise the particles collected may not be representative of those in the test atmosphere (**1**).[3] For sampling in the open, a nozzle is not needed.

5.1.1.1 *Filter Holder*—The filter holder must be such as to hold the proper size of filter without waste of filtering area and without chance of channeling or leak around the filter. An inert metal screen or other mechanical support usually is required to prevent rupture or displacement of the filter in service. If the holder is not properly designed, flow through the medium will not be uniform over the face of the filter. Uniform flow distribution is especially desirable where particle counts are to be made. Many kinds of filter media are available, and the one selected should best suit the purpose for which the particle collection is made. Properties of various media have been published (**2**).

5.1.1.2 *Flow Meter*—The flow meter may be of the orifice type, a rotameter, bellows gas meter, rotary gas meter, or other recognized device. In any case, it must be carefully calibrated under the conditions of use to give an accurate measure of sample volume or flow rate.

5.1.1.3 Various types of air-moving equipment may be employed to draw the sample of air or gas through the system, the most usual being a turbine-type blower, mechanical vane pump, piston or diaphragm pump, or ejector. For large volumes and for long sampling periods, turbine blowers are most satisfactory; multi-stage units are preferred since they will provide the necessary pressure drop. Mechanical pumps are particularly useful where there is high flow resistance in the system (caused by special filters, long sampling lines, etc.). Except for flow rates of 1 ft^3/min (0.028

[1] This recommended practice is under the jurisdiction of ASTM Committee D-22 on Sampling and Analysis of Atmospheres and is the direct responsibility of Subcommittee D22.03 on Ambient Atmospheres and Source Emissions.

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[2] *Annual Book of ASTM Standards*, Vol 11.03.

[3] The boldface numbers in parentheses refer to the list of references at the end of this recommended practice.

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D 1357 Practice for Planning the Sampling of the Ambient Atmosphere[2]

D 1704 Test Method for Determining the Amount of Particulate Matter in the Atmosphere by Measurement of the Absorbance of a Filtered Sample[2]

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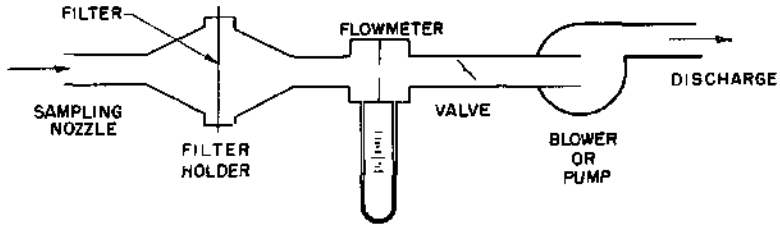

FIG. 1 Typical Arrangement of Apparatus Parts for Particle Collection by Filtration

m^3/min) or less, ejectors are not recommended. If the system under test is at a higher pressure than some available exhaust point, or if there is a pressure drop across two parts of the system, it may be possible to use this existing pressure differential to draw the sample.

5.1.1.4 Control of the sampling rate may be maintained by adjustment of a flow valve between the flowmeter and pump, by adjustment of a bleed valve at the pump inlet, or by use of a constant-flow orifice. It is sometimes possible and desirable to vary the voltage input into a mechanical pump motor in order to provide flow adjustment.

5.2 *Installed Collectors*—In areas where the atmosphere or other gas must be sampled periodically or continuously, fixed sampling stations are often installed. These may be manual or automatic (see, for example, Test Method D 1704). In either case, the principles discussed in 5.1 must apply.

5.3 *Miniature Sampler*—A number of sample collecting units[4] have been designed in miniature so that they are easily portable and capable of operation from an automobile or other battery power supply. Although the reduced size imposes some limitations (sampling rate, for example), these units are acceptable if in accordance with 5.1.

5.4 *"High-Volume" Sampler*—These compact and portable collectors consisting of a large area filter holder, high-capacity blower, and built-in flow indicator are available in commercial models.[5] They are designed to handle large flow rates of air, perhaps to 100 ft^3/min (2.8 m^3/min) or more. Also, custom made units are obtainable.

5.5 *Membrane Filter Sampler*—This type of filter medium has a limited collection capacity but is ideally suited for particle counts, particle size measurements, study of particle characteristics, and assay of living organisms (3). Membrane filters and accessories are available commercially.[6]

5.6 *General-Purpose Collectors*—There are various designs and sizes of shop or laboratory-built collectors, all of which are applicable to this recommended practice provided that the general considerations given in 5.1 are not violated.

5.7 *Laboratory Equipment for Particle Analysis:*

5.7.1 *Drying Oven*—Any reliable electric oven that may be operated continuously at a controlled temperature level of 110°C.

5.7.2 *Weighing Balance*—A laboratory analytical balance capable of weighing to ±0.05 mg.

5.7.3 *Microscope*—General purpose type with magnification range to about 1000×; eyepiece scale, whipple disk, or other reticule; stage micrometer; and suitable light source.

5.7.4 *Miscellaneous Apparatus*—Lightweight metal cans with covers; desiccators and forceps.

6. Precautions

6.1 Many pumps tend to give off a fine fog of lubricant that can quickly contaminate a filter. This contamination should be avoided either by placement of an efficient cleanup filter on the pump discharge line to remove the oil fog, or by ensuring that the discharge is vented out of doors or well downwind of the filter.

6.2 Automobile exhausts are another source of oil fog that must be avoided. When sampling over long periods of time out of doors, protection should be provided against rain. Most filters are seriously affected when they become wet.

6.3 During the sampling period the filter will tend to become filled and the flow rate may decrease as filter resistance increases. Therefore, it may be necessary to adjust the flow rate frequently or provide for essentially constant flow automatically (as with a critical flow orifice). Otherwise, an accurate record of flow rate throughout the sampling period must be maintained.

7. Sampling

7.1 *Sampling*—Sample in accordance with Practice D 1357.

7.2 *Selection of Sampler and Filter Media*—Based upon the purpose for which the sample is to be taken, determine from Table 1 the sampler to be used and the appropriate filter medium (Note). Follow that method below which is applicable. Where very small particles (1.0 μm or less in diameter) are of special interest, a high-efficiency filter medium should be used.

NOTE—There are many types of filter media available and any one may be used, provided that it has the proper performance characteristics. The four indicated in Table 1 have been selected as capable of meeting most situations that may be encountered. For more detailed information see Ref. (2).

8. Procedure

8.1 *Mass Concentration*—Use either the high volume sampler or a general-purpose, laboratory-built unit, as de-

[4] Miniature sample collecting units may be obtained from the following suppliers:
Gelman Instrument Co., Chelsea, MI.
Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh, PA 15208.
Gast Manufacturing Co., Benton Harbor, MI.
General Metal Works, Bridgetown Rd., Cleves, OH.

[5] The "high-volume" sampler may be obtained from the following suppliers:
Gelman Instrument Co., Chelsea, MI.
Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh, PA 15208.
Staplex Co., 777 Fifth Ave., Brooklyn, NY 10033.
Union Industrial Equipment Co., 40 Beech St., Port Chester, NY.
Production Equipment Co., 6432 Cass Ave., Detroit, MI.

[6] Membrane filters are available from the following suppliers:
Millipore Filter Corp., Bedford, MA.
Gelman Instrument Co., Chelsea, MI.
Carl Schleicher & Schuell, Keene, NH.