Designation: D4532 – 22

Standard Test Method for Respirable Dust in Workplace Atmospheres Using Cyclone Samplers[1]

This standard is issued under the fixed designation D4532; 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.

1. Scope

1.1 This test method provides details for the determination of respirable dust concentration defined in terms of international convention in a range from 0.5 mg/m^3 to 10 mg/m^3 in workplace atmospheres, depending on sampling time. Specifics are given for sampling and analysis using any one of a number of commercially available cyclone samplers.

1.2 The limitations on the test method are a minimum weight of 0.1 mg of dust on the filter, and a maximum loading dependent on sampler type and time of sampling. The test method may be used at higher loadings if the flow rate can be maintained constant.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 This test method contains notes that are explanatory and are not part of the mandatory requirements of the method.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres
D3195 Practice for Rotameter Calibration
D5337 Practice for Flow Rate Adjustment of Personal Sampling Pumps
D6062 Guide for Personal Samplers of Health-Related Aerosol Fractions
D6552 Practice for Controlling and Characterizing Errors in Weighing Collected Aerosols
D7440 Practice for Characterizing Uncertainty in Air Quality Measurements
E1 Specification for ASTM Liquid-in-Glass Thermometers
E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

2.2 *Other International Standards:*[3]

ISO GUM Guide to the Expression of Uncertainty in Measurement, ISO Guide 98
ISO 7708 Air Quality—Particle Size Fraction Definitions for Health-Related Sampling
ISO 13137 Workplace Atmospheres – Pumps for Personal Sampling of Chemical and Biological Agents – Requirements and Test Methods
ISO 15767 Workplace Atmospheres—Controlling and Characterizing Errors in Weighing Collected Aerosol
ISO 18158 Workplace Atmospheres - Terminology
EN 481 Workplace Atmospheres—Size Fraction Definitions for the Measurement of Airborne Particles in the Workplace
EN 13205 Workplace Atmospheres—Assessment of Performance of Instruments for Measurement of Airborne Particle Concentrations

3. Terminology

3.1 For definitions of terms used in this test method, refer to Terminology D1356.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *respirable fraction*—mass fraction of total airborne particles which penetrate to the unciliated airways. **(ISO 18158)**

[1] This test method is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.04 on Workplace Air Quality.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.2.2 *respirable sampler*—aerosol sampler that is used to collect the fraction of airborne particles according to the respirable convention (see Terminology D1356) from the surrounding air. **(modified from ISO 18158)**

3.2.2.1 *Discussion*—Fig. 1 shows the collection efficiency of an idealized sampler following the internationally-harmonized sampling conventions of ISO 7708, EN 481, Guide D6062, and Ref. (**1**).[4]

NOTE 1—The definition of the respirable convention is a compromise between previous definitions, available samplers, and the fraction of dust that penetrates to (rather than deposits in) the alveolar region of the lung. Local legal definitions may differ from the definition adopted in this test method.

3.3 For terms and definitions related to characterizing uncertainty, see ISO GUM (ISO Guide 98) and Practice D7440.

4. Summary of Test Method

4.1 Air is drawn through a cyclone or equivalent sampler followed by a tared filter, which is then re-weighed to determine the mass of respirable dust. The air flow rate and time of sampling provide the volume from which the dust mass was sampled. A time-weighted average respirable dust concentration is calculated by dividing the mass by the total air volume.

NOTE 2—Samplers alternative to a cyclone (for example, foam-based or personal cascade impactors) are commercially available. Nevertheless, this test method is limited to cyclone samplers.

5. Significance and Use

5.1 This test method covers the determination of respirable dust concentration in workplace atmospheres.

5.2 Variations of the test method are in world-wide use for determining compliance relative to occupational exposure levels.

5.3 The test method may be used to verify dust control measures.

[4] The boldface numbers in parentheses refer to a list of references at the end of this standard.

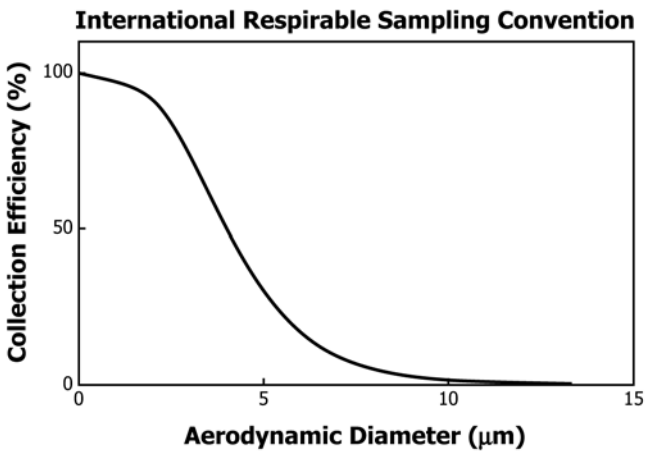

FIG. 1 Collection Efficiency of an Ideal Sampler Following the International Sampling Conventions

5.4 The test method may also be applied in research into health effects of dust in an occupational setting.

6. Apparatus

6.1 *Sampling Unit*—The sampling unit consists of a pump, a sampling head, and tubing connecting the pump and outlet of the sampling head. The sampling head consists of a cyclone and a filter assembly.

6.1.1 *Respirable Dust Cyclone*—Various types of respirable dust cyclones are commercially available. In general, these samplers can be categorized into two groups, high flow rate cyclone samplers (flow rate range 4.2 L/min – 10 L/min) and medium flow rate cyclone samplers (flow rate range 1.7 L/min – 2.75 L/min). High flow rate samplers should be considered for workplaces where airborne particle concentrations are low (for example, <0.05 mg/m^3) or where it is desirable to take short-term exposure measurements (for example, <4 h) (**2-4**).

6.1.1.1 Bias relative to the international respirable dust criterion and the dust size distribution being sampled (**2-13**) must be controlled sufficiently (see 13.2.4) for the application of intended use.

6.1.2 *Filter Cassette Assembly*—Filter, filter-support pad, and filter cassette holder with suitable caps. The filter shall be non-hygroscopic and provide a collection efficiency greater than 95 % for the dust of interest.

6.1.2.1 As an example, most glass fiber and membrane filters with nominal pore size of 5 µm will fulfill this requirement (**14**). PVC filters are recommended for gravimetric analysis. The equilibrated filter is preweighed by the user.

6.1.2.2 It is preferable to use a conductive cassette because electrostatic charge on the dust and a non-conductive cassette can result in a significant bias (**15-20**). For controlling dust which may become attracted to the interior cassette walls, several filter holders equipped with a shielded respirable dust filter and cassette are commercially available, which may be weighed together with the filter.

6.1.3 *Personal Sampling Pump*—With a flow rate uncertainty (see 13.2.1) less than 5 %. The pump pulsation amplitude may not exceed ±10 % of the mean flow according to ISO 13137 method (**21**) or ±25 % of the mean flow if pump pulsation is measured at the inlet of the cyclones (**22**). The nominal sampling flow rate for each cyclone type is adjusted using Practice D5337.

NOTE 3—Cyclone samples collected with pulsating flow have been shown to yield a negative bias as large as 70 % compared to samples collected under steady flow (**22**).

6.2 *Charger*—Pumps shall be completely charged with an appropriate charger or with replacement disposable batteries, following manufacturer's instructions.

6.3 *Weighing Room*—With temperature (20 °C ± 2 °C) and humidity (50 % Relative Humidity (RH) ± 5 % (RH)) control to allow weighing with an analytical balance to accuracy required. See ISO 15767 and Practice D6552 for controlling and characterizing errors in weighing collected aerosols.

6.3.1 If a weighing room is not available, a filter equilibration chamber can be used to equilibrate the filters in a temperature (20 °C ± 2 °C) and humidity (50 % RH ± 5 % RH) controlled chamber.