Designation: D8407 – 21

Standard Guide for Measurement Techniques for Formaldehyde in Air[1]

This standard is issued under the fixed designation D8407; 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 guide describes analytical methods for determining formaldehyde concentrations in air.

1.2 The guide is primarily focused on formaldehyde measurement technologies applicable to indoor (including in vehicle and workplace) air and associated environments (that is, chambers or bags, or both, used for formaldehyde emission testing). The described technologies may be applicable to other environments (ambient outdoor).

1.3 This guide reviews a range of commercially available technologies that can be used to measure indoor air formaldehyde concentrations. These technologies typically can measure airborne formaldehyde concentrations with detection limits in the range of 0.04 ppb_v (0.05 μg m^{-3}) to 10 ppb_v (12 μg m^{-3}). The described technologies are typically applied to research or regulatory applications and not consumer level uses.

1.4 This guide describes the principles behind each method and their advantages and limitations.

1.5 This guide does not attempt to differentiate between the effectiveness of the methods nor determine equivalence of the methods.

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

1.7 *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.*

1.8 *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

D5197 Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)

D6007 Test Method for Determining Formaldehyde Concentrations in Air from Wood Products Using a Small-Scale Chamber

E1333 Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber

2.2 *Other Standards:*

ISO 16000-3:2011 Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air — Active sampling method[3]

40 CFR § 136.6 Method modifications and analytical requirements[4]

3. Terminology

3.1 *Definitions*—For definitions and terms used in this guide, refer to Terminology D1356.

4. Summary of the Guide

4.1 This guide reviews technologies that can be used to determine formaldehyde concentrations in indoor air. Historically, ASTM methods for determining indoor formaldehyde concentrations have been based upon the chromotropic acid method (Test Methods E1333 and D6007) and derivatization using 2,4-Dinitrophenylhydrazine (Test Method D5197). However, alternative technologies have been developed to determine formaldehyde concentrations since these methods obtained consensus approval. These technologies can be time averaging methods or real-time methods. Some involve

[1] This guide is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.05 on Indoor Air.

Current edition approved Sept. 1, 2021. Published January 2022. DOI: 10.1520/D8407-21.

[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 International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

[4] Available from U.S. Government Publishing Office (GPO), 732 N. Capitol St., NW, Washington, DC 20401, http://www.gpo.gov.

the use of wet chemicals for reactions or extractions. Other methods rely on formaldehyde molecular response to differing energy inputs. The purpose of this guide is to examine the range of methods that can be used and describe the advantages and limitations of each method.

5. Significance and Use

5.1 The objective of this guide is to provide the user with an information base on commercially available instruments and technologies that can be used to measure indoor air formaldehyde concentrations.

5.2 This guide is intended as a repository for formaldehyde measurement technologies that other approved ASTM methods can reference to meet ASTM indoor air formaldehyde quantification needs.

5.3 This guide does not discuss the equivalency of the technologies presented. Each technology may have positive or negative interferences that are unique to that technology. When using a new method, equivalence with old methods should be demonstrated for each matrix, measuring environment and media (that is, each type of wood for formaldehyde emission testing in chamber environments). This is especially true when the method is intended to generate regulatory compliance data. Demonstrating equivalence or compliance, or both, is beyond the scope of this method. For guidance equivalence see references such as 40 CFR § 136.6 and CEN Guide to the Demonstration of Equivalence of Ambient Air Monitoring Methods (**1**).[5]

6. Formaldehyde Quantification Methods

6.1 There are a wide variety of commercial products that measure formaldehyde in indoor air. The methods vary in sampling time, flow rates, applicable concentration range and sensitivity (Table 1). Not all instruments that use a particular technology will be able to achieve the levels described in Table 1.

6.2 Methods with sampling times of an hour or more are typically referred to as time-averaged methods. These techniques use a sampling pump to pull a known amount of air over a sampling time of an hour or more through an impinger, derivatization cartridge, sorption tube or into a cannister. Methods with sample times of less than a minute are typically referred to as real time, semi-real time or online methods. These methods continuously draw air into an instrument. The response of the instrument varies depending on the technology. Sensitivity and sampling flows can vary for each manufacture. Values listed in Table 1 are typical values for the method.

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

TABLE 1 Typical Parameters for Formaldehyde Measurement Methods Listed in Order of Minimum Sampling Time

Method	Sampling Flow	Minimum Sampling Time	Detection Limit at Minimum Sampling Time	Typical Sampling Time	Detection Limit at Typical Sampling Time	Reference
Chromotropic acid	1 L/min	1 h	10 ppb_v (12 $\mu g\ m^{-3}$)	1 h	10 ppb_v (12 $\mu g\ m^{-3}$)	Test Method E1333[A]
Derivatization (DNPH, 2,4-Dinitrophenylhydrazine)	1 L/min	5 min	24 ppb_v (29 $\mu g\ m^{-3}$)	1 h	2 ppb_v (2.4 $\mu g\ m^{-3}$)	Test Method D5197[A]
Derivatization (Hantzsch reaction)	1 L/min	1.5 min	0.1 ppb_v (0.12 $\mu g\ m^{-3}$)	1.5 min	0.1 ppb_v (0.12 $\mu g\ m^{-3}$)	Vendor[B]
Electrochemical cell	1 L/min	1 min	10 ppb_v (12 $\mu g\ m^{-3}$)	1 min	10 ppb_v (12 $\mu g\ m^{-3}$)	Vendor[B]
Pre-concentration and thermal desorption	0.005 L/min to 0.05 L/min	1 min	5 ppb_v (6 $\mu g\ m^{-3}$)	8 min	0.6 ppb_v (0.7 $\mu g\ m^{-3}$)	Vendor[B]
Photoacoustic	1 L/min	30 s	0.8 ppb (1.0 $\mu g\ m^{-3}$)	1 min	0.5 ppb (0.6 $\mu g\ m^{-3}$)	Vendor[B]
Cavity ringdown	0.4 L/min	2 s	1.2 ppb_v (1.4 $\mu g\ m^{-3}$)	5 min	0.3 ppb_v (0.4 $\mu g\ m^{-3}$)	Vendor[B]
FTIR spectrometer with optical filter	≥1 L/min	2 s	1.0 ppb (1.2 $\mu g\ m^{-3}$)	1 min	0.2 ppb (0.2 $\mu g\ m^{-3}$)	Vendor[B]
Chemical ionization mass spectrometer	0.02 L/min to 0.2 L/min	0.1 s	10 ppb_v (12 $\mu g\ m^{-3}$)	1 min	< 0.1 ppb (< 0.12 $\mu g\ m^{-3}$)	Vendor[B]
Laser absorption spectrometer	>0.5 L/min	1 s	0.1 ppb_v (0.12 $\mu g\ m^{-3}$)	10 s	0.04 ppb_v (0.05 $\mu g\ m^{-3}$)	Vendor[B]

[A] Based on minimum reporting limit for method.
[B] Based on vendor reported values.