Designation: D7770 – 12

Standard Test Method for Collection of Volatile Organic Compounds Emitted During Simulated Manufacturing of Engineered Wood Products Via a Sealed Caul Plate Method[1]

This standard is issued under the fixed designation D7770; 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 a method for the collection of volatile organic compounds (VOC) that are emitted during the manufacture of engineered wood products using a laboratory environment designed to simulate a defined production process. The method is used for the determination of the amounts of methanol, formaldehyde, phenol and other VOC that may be emitted during conditions designed to simulate production such as hot pressing, the conditions of 'hot stacking' and 'cool-down' that occurs post-press.

1.2 The test method was originally developed to measure certain VOC from exterior plywood meeting Voluntary Product Standard PS 1–09 and structural composite lumber products such as laminated veneer lumber (LVL) meeting Specification D5456. Both of these product types are typically manufactured using phenol-formaldehyde resin based adhesives that meet Specification D2559.

1.3 The test method is suitable for many types of wood products bonded with adhesives.

1.4 This test method is specific for collecting VOC during simulated production of wood products and is not designed to determine general organic emissions from all indoor materials or sources.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use. Some specific hazards statements are given in Section 7 on Hazards.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2145 Method of Test for Phenol Content of Phenol-Water Mixtures (Withdrawn 1978)[3]

D2559 Specification for Adhesives for Bonded Structural Wood Products for Use Under Exterior Exposure Conditions

D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials

D4933 Guide for Moisture Conditioning of Wood and Wood-Based Materials

D5456 Specification for Evaluation of Structural Composite Lumber Products

E346 Test Methods for Analysis of Methanol

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

2.2 *Other Standards:*

Voluntary Product Standard PS 1–09 Structural Plywood

3. Terminology

3.1 *Definitions:*

3.1.1 *target production process*—a set of specified manufacturing parameters that define the production of an adhesive bonded wood product. For the purposes of this standard, those parameters are designed to be representative of a specific production facility and are used to derive the test specimen.

3.1.2 *test specimen*—a combination of defined wood elements with or without applied adhesive that is exposed to pressing and post pressing conditions in a defined laboratory setting that is designed to simulate the Target Production Process (see 3.1.1).

3.1.3 *VOC*—for the purposes of this standard, the term VOC means the specific volatile organic compounds of

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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] The last approved version of this historical standard is referenced on www.astm.org.

formaldehyde, methanol and phenol that are emitted from a test specimen during the pressing and post pressing measurements.

4. Summary of Test Method

4.1 A laboratory scale press is used to simulate the target production process with respect to the key variables that influence the production process and that may affect the emission of VOC. The lab press is fitted with a caul system to create a seal around the press system to permit collection of the VOC discharged during the process. The sealed caul plate contains inlet and outlet ports to permit the controlled collection of the emitted VOC.

4.2 During the test, emitted VOC collect in the air space encompassed within the sealed caul plate. The VOC are collected by mixing them into a continuous flow of clean, dry air that is injected into the sealed space via a controlled, pressurized supply cylinder.

4.3 The VOC within the collected air stream are removed from the sealed caul system and then condensed into a water solution using impingers submerged into an ice bath.

4.4 The collected solutions are diluted to concentrations ideally suited for instrumental analysis. They are analyzed to determine their methanol, formaldehyde and phenol content. Several suitable analytical procedures are referenced in Appendix X1.

4.5 The weight of the wood elements used to assemble the wood test specimen, the weight of the adhesive applied to the wood elements, and the concentrations of the VOC detected in the collection solutions are determined to be used to calculate the relative amount of methanol, formaldehyde, and phenol that are emitted during the test.

4.6 At least three test replications shall be conducted and results separately reported for each of the tests.

5. Significance and Use

5.1 Compliance with national and local air emission regulations create the need to determine volatile organic compound (VOC) emissions from adhesive-bonded structural wood products.

5.2 This method has been used to estimate the types and amounts of certain VOC that are emitted during production operations.

5.3 The method was originally developed to measure the methanol, formaldehyde, and phenol emitted in a laboratory setting that is designed to simulate the hot pressing, and post pressing conditions of hot stacking and cool down period for exterior plywood and laminated veneer lumber (LVL) processes. This current method generalizes the concept for adhesive-bonded wood products.

6. Apparatus

6.1 *Laboratory Press.* A laboratory scale press shall be equipped with automatic temperature (if hot pressing is used) and pressure controls to control the pressing conditions to simulate the production process. If required, the hot press platens can be heated with any suitable means such as electrical, hot oil or steam to control the press temperature within ±2°C (±4°F) during the pressing operation. The hot press platens shall be at least 600 by 600 mm (24 by 24 in.) and shall accommodate the sealed caul plate described in 6.2.

6.2 *Sealed Caul Plate.* A machined aluminum caul plate is fabricated to fit within the laboratory press. As shown in Fig. 1, the outside dimensions of the plate are within 125 mm (5 in.) of the outside dimension of the laboratory press. The sealed caul plate is fabricated with holes in the sides to create air 'inlet' and 'outlet' paths. The inlet and outlets are tapped to receive threaded stainless steel tubing. It is permissible to fit

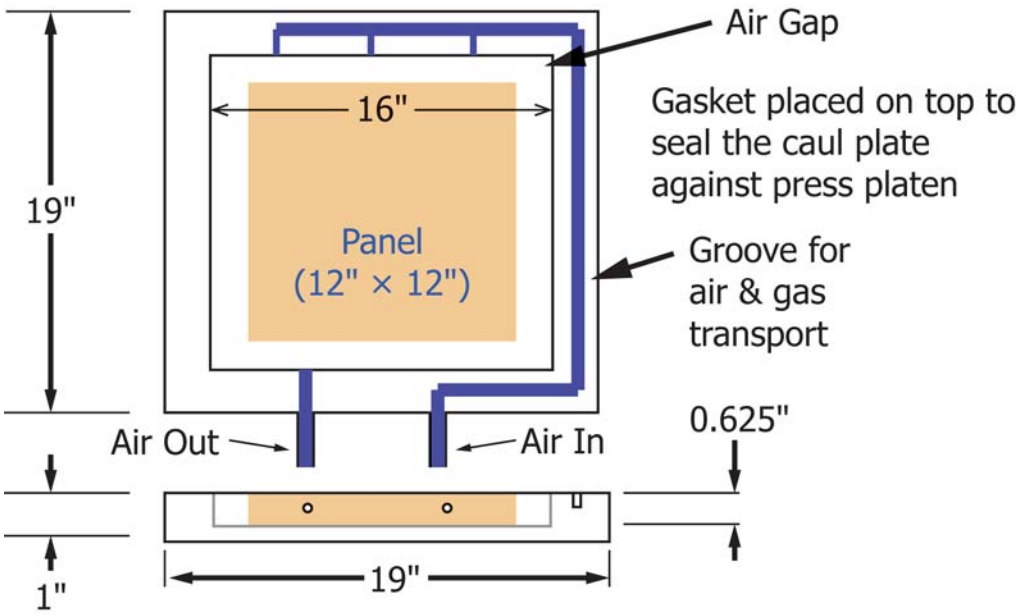

FIG. 1 Schematic of Sealed Caul Plate and Test Panel

the 'inlet' and 'outlet' tubes with quick-disconnect couplings.[4] The thickness of the sealed caul plate shall be thick enough to test the representative wood test specimen. See Fig. 2 and Note 1.

NOTE 1—Use of a spacer plate has been suitable to provide variable overall caul thicknesses to fit products with different thicknesses. In such cases, the spacer plate must be of compatible width and length to mate closely and tightly with the sealed caul plate during the test.

6.3 VOC Collection Equipment. The following equipment is required to collect the VOC during the simulated pressing operations.

6.3.1 Compressed air cylinder containing a supply of clean, dry, breathable air.

6.3.2 Gas flow meter. A meter suitable to measure gas flow rates to an accuracy of ±1.0 cm^3/min (±0.061 $in.^3$/min). [4]

6.3.3 Collection impingers.[4]

6.3.4 Teflon Socket Adapters.[4]

6.3.5 #28 Ball Joint Clips.[4]

6.3.6 Connection tubing. Teflon tubing, 6 mm (.25 in.) inside diameter with at least 1.6 mm (1/16 in.) wall thickness.

6.3.7 Ice bath. A chest or cooler of sufficient size to contain and surround three impingers with ice.

6.3.8 Amber Glass bottles

6.3.9 Gasket Material.

6.3.10 O-ring gaskets.

[4] The subcommittee chair can provide a list of suitable supplies for conducting this test.

7. Hazards

7.1 This test method involves heating, handling of wood and adhesives, pressure, presence and handling of VOC and handling of laboratory glassware.

8. Test Specimen

8.1 The test specimen is designed to simulate the target production process with respect to wood element(s), adhesive and production process. The test specimen is defined in accordance with the sections below.

8.2 Product type and wood elements. Define the wood element(s) used in the test as defined in this section.

8.2.1 Define the product type with specifics that are appropriate for that type. See Note 2.

NOTE 2—For example, plywood would be defined with respect to nominal thickness and number of plies and layers.

8.2.2 Type of wood element(s) (for example, veneer, solid sawn wood, strands, particles, and fibers).

8.2.3 Species of the wood element(s).

8.2.4 Pre-conditioning applied to the wood elements such as preheating, drying, steam exposure, chemical additions, or combinations thereof.

8.2.5 Moisture content of the wood elements shall be conditioned to be within ±2 % of the expected moisture content of the defined target production process. See Note 3. Measure the moisture content of representative matched specimens using Test Methods D4442.

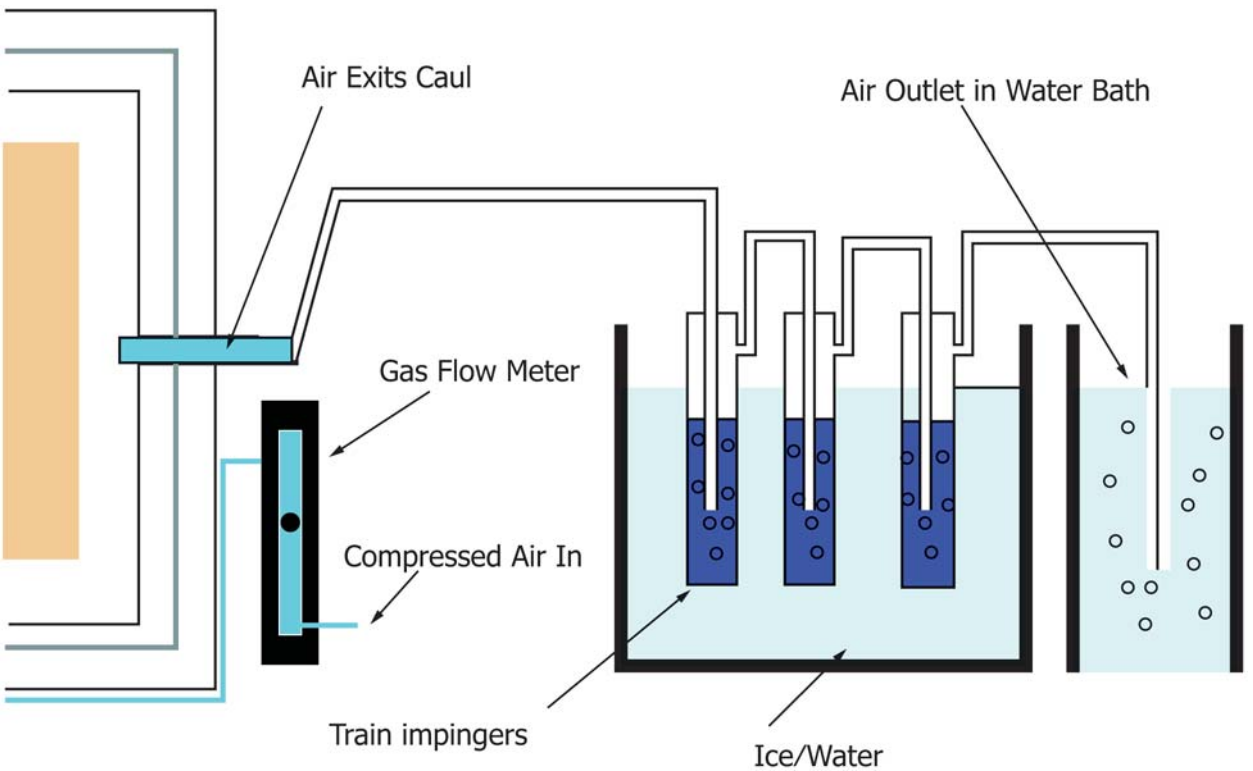

FIG. 2 Schematic of Air Source and Collection Impingers

NOTE 3— Suitable methods to achieve proper moisture preconditioning of the wood elements includes: (*a*) Sampling wood elements from the actual production process and storing the elements in controlled conditions to prevent subsequent moisture change, and (*b*) Conditioning the wood elements at a controlled humidity designed to result in the target moisture condition.

8.2.6 Temperature of the wood elements prior to testing shall be within ±5°C (±10°F) of the target production process.

8.2.7 Dimensions of the wood elements.

8.2.8 Overall dimensions of the test specimen. The test specimen shall be at least 300 by 300 mm (12 by 12 in.).

8.2.9 Configuration and alignments of the wood elements in test specimen. See Note 4.

NOTE 4—The configuration and alignment of the wood elements will depend upon the target production.

8.3 Adhesive. Define the adhesive and application method used in the test.

8.3.1 Adhesive Type (for example, phenol-formaldehyde, pMDI, urea formaldehyde, etc.)

8.3.2 Adhesive manufacturer, product number, date of manufacturing.

8.3.3 Target application rate of adhesive.

8.3.4 Application method used for the test.

8.4 Target Production Process. The test conditions shall be controlled to simulate the target production process as defined in this section.

8.4.1 The adhesive application method and application rate. The specified time between adhesive application and pre-press.

8.4.2 The prepress condition (time, prepress pressure, etc).

8.4.3 The pressing condition (time, pressure, temperature, etc.).

9. VOC Collection Procedures

9.1 Obtain and moisture condition wood elements to target moisture/temperature condition.

9.2 Obtain adhesive. Precondition adhesive if that is part of the target test condition.

9.3 Prepare hot press and sealed caul plate. Permit stabilization of the hot press and sealed caul plate to the target platen temperature.

9.4 Prepare one set of three collection impingers for the pressing stage and another set of three impingers for the post-pressing stage, if needed, as follows:

9.4.1 Determine and record weight of each collection impinger to an accuracy of 0.1 g.

9.4.2 Add 200 ml ±5 ml of deionized water to each collection impinger, remeasure, and record wet weight.

9.4.3 Assemble one set of three collection impingers in the ice bath. Assure that the impingers are below the level of the collection solution (deionized water). Connection of the impingers to the outlets is not made at this time.

9.5 Apply the adhesive to the wood elements. Record the following information:

9.5.1 Temperature of surrounding conditions,

9.5.2 Temperature of adhesive,

9.5.3 Temperature of wood elements,

9.5.4 Weight of wood elements before adhesive application,

9.5.5 Weight of wood elements after adhesive application, and

9.5.6 Time between adhesive application and pressing.

9.6 Connect the collection impingers to the outlet ports of the sealed caul plate and open all valves between the sealed caul and the impingers.

9.7 Turn the clean air supply on and adjust to maintain a flow rate of 1.8 ±.1 L/min (110 ±6.1 $in.^3$/min). See Note 5.

NOTE 5—There should be no gas flow through the impingers at this point because the caul system is still open to the atmosphere.

9.8 Assemble the test specimen into the press and begin the pressing process. When properly adjusted, the press pressure shall be sufficient to create a tight seal between the press and sealed caul plate. Record the press pressure. See Note 6. This results in the air supply creating a positive gas pressure such that there is a gas flow from the sealed space around the test specimen to the impingers.

NOTE 6—The press pressure may be greater than the target pressure for the process.

9.9 When required, the hot pressing conditions are controlled to the defined test conditions (see 8.4.3). During this step, the air flow rate is maintained at 1.8 ±0.1 L/min (110 ±6.1 $in.^3$/min).

9.10 At the end of the press process, the press heat (if used) is turned off and the first set of impingers is detached from the outlet air stream, sealed and removed from the ice bath. At that point, the second set of three impingers are used to collect an emission sample in accordance with sections 9.11 and 9.12 to determine VOC emissions representative of the post-press "hot-stack" condition. The steps in sections 9.11 and 9.12 are not required if not representative of the target production process.

9.11 The press pressure is maintained to continue the tight seal between the press platen and sealed caul plate. The second set of impingers collects the output from the outlet air stream as soon as the press process is completed. See Notes 7 and 8.

NOTE 7—Since the press pressure must be maintained to continue the tight seal, the post press stage may not be representative of actual production processes where there is full release of press pressure and potential of emissions of VOC from the faces. In addition, the temperature conditions may not represent actual production conditions. The results from the post pressing condition may provide useful comparative data of emission through edges during the post pressing stage.

NOTE 8—The transition between the two sets of impingers is optimally executed by having the second set of impingers ready in a second ice bath and using a two way valve located just downstream of the outlet port to switch between the two sets of impingers.

9.12 The second set of impingers collects the output air stream for the duration of the post press hot stack period.

9.13 At the end of the sample collection period, the press is opened and the air supply is turned off. The impingers are detached from the outlet, sealed and removed from the ice bath.

9.14 After disconnection from the sealed caul plate apparatus and removal from the ice water bath, the outsides of the collection impingers (and their corresponding connection

tubes) are promptly dried off. The connection tubes are removed and each impinger is weighed to determine its 'final' weight. See Note 9.

NOTE 9—The 'net' weights of the VOC's collected in each impinger are calculated by subtracting the respective impingers' 'wet' weights (measured in 9.4.2) from their 'final' weights.

9.15 Determine the weight of each dry amber jar.

9.16 The contents of each set of collection impingers are then transferred into an amber glass jar. Reweigh and record the weight of each amber jar.

9.17 Each set of collection impingers and its respective connection tubing are rinsed three times with small quantities of de-ionized water; each rinse solution is transferred into the same amber jar that the contents of the impinger were transferred into. Reweigh the amber jars and determine the net weigh of solution in each jar.

9.18 Seal and refrigerate the amber jar(s) at 4 ±2°C.

10. Analytical Procedures

10.1 Analytical procedures will depend on the target VOC, required precision and other aspects that are beyond the scope of this standard. See nonmandatory Appendix X1 for discussion of analytic considerations for collected VOC determinations.

11. Report

11.1 Report the following information related to each of the test specimens:

11.1.1 Wood element type, species, dimensions,

11.1.2 Adhesive type, manufacturer, application rate,

11.1.3 Test specimen dimensions,

11.1.4 Test specimen pressing process, including time/temperature/pressure regime,

11.1.5 Post press conditions,

11.1.6 Weight of solution in each jar, and

11.1.7 Net weight of total VOC and each specific VOC collected in each individual jar.

12. Precision and Bias

12.1 The precision of this method has not yet been determined.

13. Keywords

13.1 formaldehyde; methanol; phenol; pressed wood; VOC

APPENDIX

(Nonmandatory Information)

X1. ANALYTICAL METHODS

X1.1 This nonmandatory appendix describes procedures and considerations for determining the VOC content from the solution samples collected from this method.

X1.2 Aliquots of the solutions are used to analytically determine the concentration of the target VOC.

X1.3 The following methods are suitable for the determination of specific VOC.

X1.4 Conduct each analytical test in triplicate for each jar and average the concentration result.

X1.5 Determine the gross emission result by multiplying the concentration result by the net weight of the amber jar solution weight.

X1.6 For each of the VOC, determine the emission rate from the test specimen by dividing the concentration result by the gross weight of the wood plus adhesive.

X1.7 To determine the VOC from the wood (without adhesive), conduct a matching test on wood specimens without adhesive, but with water added to the wood specimens in the same amount as contained in the adhesive. This establishes the wood VOC emission rate. Subtract these VOC emissions to determine net emissions from the adhesive.

X1.8 For each of the VOC, determine the net emission rate for the adhesive by dividing the concentration result by the gross weight of adhesive.