
Standard Method of Test for

Quantitative Extraction of Asphalt Binder from Asphalt Mixtures

AASHTO Designation: T 164-22¹

Technically Revised: 2022

Editorially Revised: 2022

Technical Subcommittee: 2c, Asphalt–Aggregate Mixtures

ASTM Designation: D2172/D2172M-11



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. These methods cover the quantitative determination of asphalt binder in hot mix asphalt (HMA) and HMA pavement samples. Aggregate obtained by these methods may be used for sieve analysis using T 30.
- 1.2. The values stated in SI units are to be regarded as the standard.
- 1.3. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns 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.* Specific hazards are given in Section 8.
Note 1—The results obtained by these methods may be affected by the age of the material tested, with older samples tending to yield slightly lower asphalt binder contents. Best quantitative results are obtained when the test is made on HMA mixtures and pavements shortly after their preparation. It is difficult to remove all the asphalt binder when some aggregates are used; some solvent may remain within the mineral matter affecting the measured asphalt binder content.
- 1.4. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 231, Weighing Devices Used in the Testing of Materials
 - M 339M/M 339, Thermometers Used in the Testing of Construction Materials
 - R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
 - R 59, Recovery of Asphalt Binder from Solution by Abson Method
 - R 97, Sampling Asphalt Mixtures

- T 30, Mechanical Analysis of Extracted Aggregate
- T 84, Specific Gravity and Absorption of Fine Aggregate
- T 110, Moisture or Volatile Distillates in Hot Mix Asphalt (HMA)
- T 228, Specific Gravity of Semi-Solid Asphalt Materials
- T 329, Moisture Content of Asphalt Mixtures by Oven Method

2.2. *ASTM Standards:*

- C670, Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials
- D604, Standard Specification for Diatomaceous Silica Pigment (withdrawn 2003; no replacement)
- D2111, Standard Test Methods for Specific Gravity and Density of Halogenated Organic Solvents and Their Admixtures
- D4080, Standard Specification for Trichloroethylene, Technical and Vapor-Degreasing Grade
- D6368, Standard Specification for Vapor-Degreasing Solvents Based on *normal*-Propyl Bromide and Technical Grade *normal*-Propyl Bromide
- E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
- E1137/E1137M, Standard Specification for Industrial Platinum Resistance Thermometers
- E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standards:*

- IEC 60584-1: 2013 Thermocouples - Part 1: EMF Specifications and Tolerances
- IEC 60751: 2008 Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors

2.4. *Federal Standard:*

- Fed. Std. No. 29, CFR 1910.1200 OSHA Hazard Communication Standard; see also Permissible Exposure Limits—Annotated Tables, available at <https://www.osha.gov/dsg/annotated-pels/>

3. TERMINOLOGY

- 3.1. *nominal maximum size (of aggregate)*—one size larger than the first sieve that retains more than 10 percent aggregate.
- 3.2. *constant mass*—shall be defined as the mass at which further drying does not alter the mass by more than 0.05 percent when weighed at 2-h intervals.

4. SUMMARY OF TEST METHODS

- 4.1. The HMA is extracted with trichloroethylene, *n*-propyl bromide, or methylene chloride, using the extraction equipment applicable to the particular method. Terpene extractant may be used in Method A or E. The asphalt binder content is calculated by differences from the mass of the extracted aggregate, moisture content, and mineral matter in the extract. The asphalt binder content is expressed as a mass percent of moisture-free mixtures.

5. SIGNIFICANCE AND USE

- 5.1. All of the methods can be used for quantitative determinations of asphalt binder in HMA mixtures and pavement samples for specification acceptance, service evaluation, quality control, and research. Each method prescribes the solvents and any other reagents that can be used in the method. R 59 requires that Method A or E (Note 2) and reagent-grade trichloroethylene be used when asphalt binder is recovered from solution.

Note 2—The vacuum extractor, Section 22.1.1, can be modified by a vacuum trap attached to the top of the “end point” sight tube to collect the extract to allow its use for recoveries (Figure 4b).

6. APPARATUS

- 6.1. *Oven*—Capable of maintaining the temperature at $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$), for warming the sample. Oven(s) for heating shall be capable of operation at the temperatures required, between 100 to 120°C (212 to 248°F), within $\pm 5^\circ\text{C}$ ($\pm 9^\circ\text{F}$), as corrected, if necessary, by standardization. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the temperature of materials shall meet the requirements of M 339M/M 339 with a temperature range of at least 90 to 130°C (194 to 266°F), and an accuracy of $\pm 1.25^\circ\text{C}$ ($\pm 2.25^\circ\text{F}$) (see Note 3).

Note 3—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class, Type T any Class; IEC 60584 thermocouple thermometer, Type J or K, Class 1, Type T any Class; or dial gauge metal stem (bi-metal) thermometer.

- 6.2. *Oven*—Capable of maintaining the temperature at 149 to $163 \pm 5^\circ\text{C}$ (300 to $325 \pm 9^\circ\text{F}$), for drying the sample if the moisture content is not determined. Oven(s) for drying shall be capable of operation at the temperatures required, between 145 to 170°C (293 to 338°F), within $\pm 5^\circ\text{C}$ ($\pm 9^\circ\text{F}$), as corrected, if necessary, by standardization. More than one oven may be used, provided each is used within its proper operating temperature range. The thermometer for measuring the temperature of materials shall meet the requirements of M 339M/M 339 with a temperature range of at least 140 to 175°C (284 to 347°F), and an accuracy of $\pm 1.25^\circ\text{C}$ ($\pm 2.25^\circ\text{F}$) (see Note 4).

Note 4—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E230/E230M thermocouple thermometer, Type J or K, Special Class, Type T any Class; or IEC 60584 thermocouple thermometer, Type J or K, Class 1, Type T any Class.

- 6.3. *Pan*—Flat, of appropriate size.

- 6.4. *Balance*—The balance shall have sufficient capacity, be readable to 0.1 percent of the sample mass or better, and conform to the requirements of M 231.

- 6.5. *Cylinders*—Graduated, 1000- or 2000-mL capacity.

7. REAGENTS

- 7.1. *Methylene Chloride*—Technical grade. *Caution*—see Section 8.

- 7.2. *n-Propyl Bromide*—Conforming to ASTM D6368—see Section 8.

- 7.3. *Trichloroethylene*—Reagent grade (Note 5) or conforming to ASTM D4080—see Section 8.

- 7.4. *Terpene*—Extractant, shall be nonhalogenated, nontoxic, and shall readily dissolve asphalt binder from HMA and place it into solution. This extractant shall be easily rinsed from the remaining

aggregate without forming a gel, and the extractant rinsed from the aggregate shall pass readily through the diatomaceous earth and the filter.

- 7.5. When asphalt binder is intended to be extracted and then tested for additional properties, a reagent-grade solvent must be used (Note 5).

Note 5—Non-reagent-grade solvents may contain epoxy resins that may affect the properties of the recovered binder. In particular, certain acid modified binders may be affected by non-reagent-grade solvents.

Note 6—Only vented ovens should be used when terpene extractants are used.

8. PRECAUTIONS

- 8.1. The solvents listed in Section 7 should be used only under a hood or with an effective surface exhaust system in a well-ventilated area, because they are all toxic to some degree, as described in 29 CFR 1910.1200. Trichloroethylene, methylene chloride, and *n*-propyl bromide in the presence of heat and moisture may form acids that are extremely corrosive to certain metals, particularly when subject to contact over lengthy periods of time. Proper precautions should be taken to not allow these solvents to remain in small quantities in the effluent tanks of aluminum vacuum extractors.
- 8.2. Trichloroethylene stored in a steel container and in continuous contact with moisture may decompose by dehydrohalogenation to form unsaturated hydrocarbon liquids and hydrogen chloride. Steel drums containing trichloroethylene should be stored in a cool, dry location, kept tightly sealed, and opened as infrequently as possible. Trichloroethylene should be transferred from the drums to clean, dry, brown glass bottles for laboratory use. The hydrogen chloride in decomposed trichloroethylene may harden an asphalt during the extraction and Abson recovery test (R 59).
- 8.3. All local, state, and federal regulations must be followed when hauling, using, storing, and discarding extractants and rinse water. These requirements include fire ordinances as well as wastewater treatment regulations. The Material Safety Data Sheet should be followed closely to avoid fires and explosions. Storage of extractant-soaked rags should be prohibited.

9. SAMPLING

- 9.1. Obtain samples in accordance with R 97.
- 9.2. *Preparation of Test Specimens:*
- 9.2.1. If the HMA is not sufficiently soft to separate with a spatula or trowel, place it in a large, flat pan, and warm it in a $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$) oven only until it can be handled or separated. Split or quarter the material until the mass of material required for the test is obtained.
- 9.2.2. The size of the test sample shall be governed by the nominal maximum aggregate size of the HMA and conform to the mass requirement shown in Table 1 (Note 7).

Table 1—Size of Sample

Nominal Maximum Aggregate Size		Minimum Mass of Sample, kg
mm	in.	
4.75	No. 4	0.5
9.5	$\frac{3}{8}$ in.	1
12.5	$\frac{1}{2}$ in.	1.5
19.0	$\frac{3}{4}$ in.	2
25.0	1 in.	3
37.5	$1\frac{1}{2}$ in.	4

Note 7—When the mass of the test specimen exceeds the capacity of the equipment used (for a particular method), the test specimen may be divided into suitable increments, tested, and the results appropriately combined for calculation of asphalt binder content (Section 13).

- 9.2.3. Unless the HMA sample is free of moisture (Note 9), a test specimen is required for the determination of moisture (Section 10) in the HMA. Take this test specimen from the remaining sample in the HMA immediately after obtaining the extraction test specimen.

Note 8—If the extraction test is being performed only to recover asphalt binder from the HMA and the percent asphalt binder is not being determined, it is unnecessary to determine the moisture content of the HMA.

Table 2—Dimensional Equivalents

mm	in.	mm	in.	mm	in.
0.8	$\frac{1}{32}$	44.5	$1\frac{3}{4}$	157.2	$6\frac{3}{16}$
1.6	$\frac{1}{16}$	47.6	$1\frac{7}{8}$	158.8	$6\frac{1}{4}$
2.0	$\frac{5}{64}$	50.8	2	163.5	$6\frac{7}{16}$
3.2	$\frac{1}{8}$	55.6	$2\frac{3}{16}$	165.1	$6\frac{1}{2}$
4.0	$\frac{5}{32}$	56.4	$2\frac{7}{32}$	187.3	$7\frac{3}{8}$
4.8	$\frac{3}{16}$	57.2	$2\frac{1}{4}$	203.2	8
5.6	$\frac{7}{32}$	58.7	$2\frac{5}{16}$	247.7	$9\frac{3}{4}$
6.4	$\frac{1}{4}$	63.5	$2\frac{1}{2}$	254.0	10
7.9	$\frac{5}{16}$	66.7	$2\frac{5}{8}$	257.2	$10\frac{1}{8}$
9.5	$\frac{3}{8}$	71.4	$2\frac{13}{16}$	260.4	$10\frac{1}{4}$
12.7	$\frac{1}{2}$	76.2	3	279.4	11
15.9	$\frac{5}{8}$	88.9	$3\frac{1}{2}$	304.8	12
19.1	$\frac{3}{4}$	95.3	$3\frac{3}{4}$	320.7	$12\frac{5}{8}$
25.4	1	101.6	4	330.2	13
28.6	$1\frac{1}{8}$	108.0	$4\frac{1}{4}$	342.9	$13\frac{1}{2}$
30.2	$1\frac{3}{16}$	127.0	5	355.6	14
35.7	$1\frac{13}{32}$	138.1	$5\frac{7}{16}$	368.3	$14\frac{1}{2}$
38.1	$1\frac{1}{2}$	149.2	$5\frac{7}{8}$	384.2	$15\frac{1}{8}$
40.5	$1\frac{9}{32}$	152.4	6	393.7	$15\frac{1}{2}$
41.3	$1\frac{5}{8}$	154.8	$6\frac{3}{32}$	406.4	16
42.9	$1\frac{11}{16}$	155.6	$6\frac{1}{8}$	—	—

10. MOISTURE CONTENT

- 10.1. When required, determine the moisture content of the mixture (Section 9.2.3) in accordance with the procedure described in T 110 or T 329.

Note 9—If recovery of asphalt binder from the solution obtained from the extraction test is not required, the entire test specimen may be dried in an oven at a temperature of 105 to 165°C (221 to 329°F) to constant mass prior to extraction, instead of determining the moisture content.

- 10.2. Calculate the mass of water (W_2 , Section 13) in the extraction test portion by multiplying mass percent water (Section 10.1) by the mass of the extraction test portion (W_1 , Section 13).

TEST METHOD A

11. APPARATUS

- 11.1. *In addition to the apparatus listed in Section 6, the following apparatus is required for Method A:*

- 11.1.1. *Extraction Apparatus*—Consisting of a bowl approximating that shown in Figure 1 and an apparatus in which the bowl may be revolved at controlled variable speeds up to 3600 r/min. The speed may be controlled manually or with a preset speed control. The apparatus should be provided with a container for catching the solvent discharged from the bowl and a drain for removing the solvent. The apparatus preferably shall be provided with explosion-proof features and installed in a hood or an effective surface exhaust system to provide ventilation.

Note 10—Similar apparatus of larger size may be used.

- 11.1.2. *Filter Rings*—Felt or paper, to fit the rim of the bowl.

- 11.1.3. *Low-Ash Paper Filter Rings*—May be used in place of the felt filter ring (Section 11.1.2). Such filter rings shall consist of low-ash filter paper stock, 1.27 ± 0.13 mm (0.05 ± 0.005 in.) thick. The nominal base weight of the paper shall be 150 ± 14 kg (330 ± 30 lb) for a ream [500 sheets, 635 by 965 mm (25 by 38 in.)]. The ash content of the paper should not exceed 0.2 percent (approximately 0.034 g per ring).

Note 11—Where terpene extractants are used, the gears and shaft should be lubricated frequently.