
Standard Method of Test for

Asphalt Binder Content of Asphalt Mixtures by the Nuclear Method

AASHTO Designation: T 287-22

Technically Revised: 2022

Editorially Revised: 2022

Technical Subcommittee: 2c, Asphalt–Aggregate Mixtures



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1. SCOPE

- 1.1. This procedure covers the quantitative determination of the asphalt binder content of asphalt mixtures by testing a sample with a nuclear gauge that utilizes neutron-thermalization techniques.
- 1.2. The values expressed in SI units are to be regarded as the standard. The inch-pound equivalents of the SI units may be approximate.
- 1.3. Nuclear gauge operations and maintenance are not covered in detail. See the manufacturer's manual for details.
- 1.4. *This test method involves potentially hazardous materials, operations, and equipment. This method does not purport to address all of the safety concerns associated with its use. All operators will be trained in radiation safety prior to operating nuclear gauges. Some agencies require the use of personal monitoring devices such as a thermoluminescent dosimeter or film badge.*
- 1.5. *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 66, Sampling Asphalt Materials
 - R 76, Reducing Samples of Aggregate to Testing Size
 - R 90, Sampling Aggregate Products
 - R 97, Sampling Asphalt Mixtures
 - T 11, Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
 - T 27, Sieve Analysis of Fine and Coarse Aggregates

- < T 110, Moisture or Volatile Distillates in Hot Mix Asphalt (HMA)
- < T 255, Total Evaporable Moisture Content of Aggregate by Drying
- < T 329, Moisture Content of Asphalt Mixtures by Oven Method

2.2. *ASTM Standards:*

- < E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- < E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- < E2877, Standard Guide for Digital Contact Thermometers

2.3. *International Electrotechnical Commission Standard:*

- < IEC 60584-1: 2013 Thermocouples - Part 1: EMF Specifications and Tolerances

3. SUMMARY OF METHOD

- 3.1. This procedure can be used for rapid determination of the asphalt binder content of asphalt mixtures. It is suitable for quality control and acceptance testing for construction and for research and development applications. This procedure is useful in the determination of asphalt binder content only and does not provide for gradation analysis.
- 3.2. This procedure determines the asphalt binder content of a test sample by comparing the measured asphalt binder content with previously established calibration data. The asphalt binder content is expressed as a percentage of the mass of the asphalt mixture.
- 3.3. Accurate results are dependent on proper calibration of the nuclear gauge to the material being tested as covered in Annex A. This procedure is sensitive to the type and gradation of the aggregate, liquid anti-stripping additive or hydrated lime, and the percentage and source of the asphalt binder.
- 3.4. This procedure measures the total amount of hydrogen in a sample including the hydrogen present in the form of water. Unless the test sample is totally free of water, the moisture content must be determined according to T 110 or T 329 and the percentage subtracted from the asphalt binder content measured by the nuclear gauge. Alternatively, prior to testing, the sample may be dried to a constant mass in accordance with T 329, thereby nullifying the need for a moisture correction.
- 3.5. This procedure can be used with recycled asphalt pavement (RAP) incorporated into the asphalt mixture, provided that the RAP is of uniform gradation, asphalt binder content, and asphalt binder type. When RAP is used, the RAP should be mixed in the calibration samples in the same proportion that it will be used on the construction project.

4. APPARATUS

- 4.1. *Nuclear asphalt binder content gauge system consisting of:*
- 4.1.1. *Neutron Source*—an encapsulated and sealed radioactive source;
 - 4.1.2. *Thermal neutron detectors*;
 - 4.1.3. *Readout instrument*—displaying, at a minimum, the percent of asphalt binder to the nearest 0.1 percent; and
 - 4.1.4. *Three or more stainless-steel sample pans*—conforming to the gauge requirements.

- 4.2. Mechanical mixer with a 10-kg (22-lb) capacity, capable of producing a completely mixed, well-coated, homogeneous asphalt mixture.
- 4.3. Sample containers such as paint cans or unwaxed, nonabsorbent cardboard boxes that can be closed to prevent contamination of the sample and are capable of withstanding the heating of the asphalt mixture to the mixing temperature.
- 4.4. Sample-quartering apparatus conforming to the requirements of R 76, Method B.
- 4.5. General-purpose balance or scale conforming to M 231, 20-kg (44-lb) capacity, readable to 0.1 g.
- 4.6. *Drying Oven*—capable of handling the required number of samples and sample sizes, of either of the following types:
 - 4.6.1. Forced-air convection oven capable of maintaining a temperature of $177 \pm 3^{\circ}\text{C}$ ($350 \pm 5^{\circ}\text{F}$).
 - 4.6.2. Microwave oven, determined not to be detrimental to the aggregate, capable of maintaining a temperature of $177 \pm 3^{\circ}\text{C}$ ($350 \pm 5^{\circ}\text{F}$).
- 4.7. *Leveling Plate*—flat, rigid plate of metal [minimum thickness of 10 mm (0.4 in.)], Plexiglas [minimum thickness of 12.5 mm (0.5 in.)], or nonabsorptive plywood [minimum thickness of 19 mm (0.75 in.)], slightly larger than the sample pans.
- 4.8. Thermometer with a temperature range of 10 to 260°C (50 to 500°F) and an accuracy of $\pm 0.5^{\circ}\text{C}$ ($\pm 0.9^{\circ}\text{F}$), meeting the requirements of M 339M/M 339 (Note 1).
Note 1—Thermometer types suitable for use include ASTM E1 mercury thermometers; ASTM E2877 digital metal stem thermometer; ASTM E230/E230M thermocouple thermometer, Type T, Special Class; or IEC 60584 thermocouple thermometer, Type T, Class 1.
- 4.9. Assorted pans, spoons, spatulas, and mixing bowls.
- 4.10. *Radioactive materials information/calibration packet containing:*
 - 4.10.1. Daily standard count log;
 - 4.10.2. Factory/laboratory calibration data sheet;
 - 4.10.3. Leak test certificate;
 - 4.10.4. Shipper's declaration for dangerous goods;
 - 4.10.5. Procedure memo for storing, transporting, and handling nuclear testing equipment; and
 - 4.10.6. Other radioactive materials documentation conforming to local regulatory requirements.

5. PRECAUTIONS

- 5.1. *The nuclear asphalt binder content gauge may be sensitive to outside influences and therefore:*
 - 5.1.1. Any other source of neutron radiation shall be kept at least 10 m (33 ft) from the apparatus during use;
 - 5.1.2. The space within 1 m (3.3 ft) of the apparatus shall be kept free of hydrogenous material such as water, plastics, asphalt binder, or asphalt mixtures during use;