Chapter 25

Tex-228-F, Determining Asphalt Content of Bituminous Mixtures by the Nuclear Method

Contents:

Section 1
Overview

Effective Dates: August 1999 to January 2005.

Use this method to determine the quantitative asphalt cement content of bituminous mixtures by testing a sample with a device that uses neutron thermalization techniques. It can be used for rapid determination of the asphalt cement content of bituminous mixtures and adjustments, if necessary, can be made in the asphalt cement metering system with a limited amount of mix production. This procedure is useful in determining asphalt cement content only, as it does not provide extracted aggregate for gradation analysis.

CAUTION: Only licensed operators may use nuclear gauges. The quantity of radioactive material contained in a nuclear gauge is relatively small, and the operator can use a properly operating gauge safely, day after day, without any known health hazard due to radiation exposure. However, all radioactive sources, no matter how small, must be handled with care. In the event the gauge becomes physically damaged, immediately notify the Radiation Safety Officer and do not handle or approach the gauge.

Units of Measurement

The values given in parentheses (if provided) are not considered to be standard and may not be exact mathematical conversions. Each system of units shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

Section 2

Apparatus

The following apparatus is required:

- nuclear testing gauge (with manufacturer's instruction manual and sample pan(s), able to determine the asphalt content of a sample containing between 0% to 14% asphalt cement
- balance, readable to 0.1 g, with an accuracy of 0.5 g
- oven, capable of heating to 177 ± 3 °C (350 ± 5 °F)
- plywood, 19 mm (0.75 in.) or thicker, or metal plate 9.5 mm (3/8 in.) or thicker, having an area slightly larger than the top of the gauge sample pans
- thermometer, with a temperature range of 10 to 300 °C (50 to 500 °F)
- assorted spoons, scoops, mixing bowls, trowels and/or spatulas
- wax paper
- mechanical mixing machine (optional).

Section 3
Test Record Form

Use the following forms:

- Nuclear Asphalt Content Test
- Nuclear Asphalt Content Calibration
- Other suitable worksheets.

Section 4

Precautions

The asphalt content gauge must be licensed according to applicable health and safety regulations prior to use.

Gauge operators must have received approved safety training and operational training and must wear a dosimeter badge.

Since nuclear equipment measures the total amount of hydrogen in the sample, this procedure is sensitive to changes in moisture content, because both asphalt cement and water contain hydrogen.

Keep any other source of neutron radiation at least 7.6 m (25 ft.) from the equipment during use. Do not place the equipment where large amounts of hydrogenous material may be moved during the calibration or testing procedures (Example: people, water, trucks loaded with bituminous mix or asphalt, or plastic materials).

The operator must be aware of changing conditions that could affect gauge results. Additional standardization testing must be performed if changes occur.

Section 5

Sampling

Obtain representative samples of the aggregates to be used according to test methods "Tex-204-F, Design of Bituminous Mixtures and "Tex-400-A, Sampling Stone, Gravel, Sand and Mineral Aggregates."

Obtain representative samples of the freshly produced bituminous paving mixture according to Test Method "Tex-222-F, Sampling Bituminous Mixtures."

Section 6

Preparing Test Sample

Follow these steps for preparing a test sample:

1. The sample portion to be tested must provide sufficient material per test unit to fill the gauge sample pan (approximately 10 kg [22 lbs.]).
2. The test sample must be checked for moisture content according to Test Method "Tex-212-F, Determining Moisture Content of Bituminous Mixtures." If moisture is present, the percentage determined must be subtracted from the apparent asphalt cement percentage as indicated by the nuclear method.
3. The sample may also be dried to a constant weight in an oven at 110 ± 5 °C (230 ± 10 °F), thereby nullifying the need for moisture correction.
4. The test sample must be placed in the gauge sample pan according to the manufacturer's recommended procedure.

Section 7
Calibration

This method of test is sensitive to the type of aggregate, percentage and source of asphalt, and to the mix gradation. Accordingly, develop a calibration for each mix type.

- The curve must be established with a minimum of three points.
- Develop a new calibration curve whenever there is a change in the source of asphalt or aggregate, or a significant change in aggregate gradation (generally, one requiring a new mixture design).

Following is the recommended procedure for developing the calibration curve.

Developing Calibration Curve

Step	Action
1	Sample the aggregate at the plant according to the 'Preparing Test Sample' procedure and blend the aggregates in the proper proportions. ♦ Obtain sufficient aggregate for a minimum of four samples. ♦ Approximately 40 kg (88 lbs.) total will be required.
2	♦ Mix a minimum of three asphalt concrete samples: • one at the design asphalt cement content • one at 1.0% above • one at 1.0% below the design percentage. ♦ Use the grade and type of asphalt cement that will be used in the tested asphalt concrete mixture.
3	Begin the calibration using the asphalt concrete mixture sample 1.0% above the design asphalt cement content.
4	Fill the gauge sample pan half-full, evenly distributing the sample in the pan.
5	♦ Level the asphalt concrete mixture with a trowel or spatula and spade 20 to 30 times around the perimeter to minimize voids between the sample and edges of the pan. ♦ Take care not to exert pressure on the sample.
6	♦ Fill the pan to the point that the asphalt concrete mixture is mounded slightly above the top of the pan and repeat the spading procedure. ♦ Record weight of the asphalt concrete mixture in the pan. This will be the 'base' weight that is to be used for all calibration and test samples using this calibration.
7	Level the top of the bituminous mixture using a spatula or trowel to an even head (approximately 13 mm [0.5 in.]) above the top lip of the pan.
8	♦ Use the metal or plywood plate with a covering of wax paper (to prevent sticking) to consolidate the sample in the pan until it is flush with top edges of the pan. ♦ Place the pan on the floor, with the wax paper and plate on top of the sample pan, standing on the plate. ♦ The surface of the mixture must be uniform.
9	♦ Measure and record the temperature and weight of the test sample (sample pan not included). ♦ With gauges that do not have automatic temperature correction, the sample temperature is the temperature ± 5 °C (10 °F) at which all samples and calibration pans must be counted.
10	Place the sample pan containing the asphalt concrete mixture sample in the gauge and proceed as per manufacturer's instructions for equipment operations.

Developing Calibration Curve	
Step	**Action**
11	Measure and record the 16-minute gauge count
12	Repeat the above process for the remainder of the calibration samples using the same sample weight of asphalt concrete mixture in each pan.
13	Generate a calibration curve using the software provided with the gauge. ♦ The correlation factor must be greater than or equal to 0.995 to be considered acceptable. ♦ It may be necessary to plot the calibration curve manually if the gauge cannot generate the curve internally. ♦ Reference must be made to the gauge manufacturer's user manual for specific details on generating the calibration curve (see 'Calculations').
14	Repeat the calibration procedure for each asphalt concrete mixture that is to be used.

Section 8
Calculations

Use the following to determine correlation factor:

$$Correlation\ Factor = \frac{n\left(\sum xy\right) - \left(\sum x\right)\left(\sum y\right)}{\left[n\left(\sum x^2\right) - \left(\sum x\right)^2\right] x \left[n\left(\sum y^2\right) - \left(\sum y\right)^2\right]}$$

Where:

- n = number of calibration samples
- x = percent asphalt cement
- y = sample count
- Σ = summation.

Section 9

Calibration Transfer

Some gauges will allow laboratory calibration values to be transferred to field gauges. After entering the values according to the manufacturer's procedures, the coefficient of correlation must be 0.990 or greater to be a valid transfer. If the coefficient of correlation is less than 0.990, re-enter the values and check lab-to-field gauge correlation. If the same results are achieved, the transfer is invalid and an independent calibration must be established for the field gauge.

Section 10
Field Testing

Follow these steps for field testing.

Field Testing	
Step	**Action**
1	♦ Place the test sample in the sample pan by the same method described in Steps 3 through 9 of the 'Developing Calibration Curve' procedure. ♦ The sample weight must be the same as the 'base' weight ±1 g.
2	♦ If the gauge has a temperature compensator feature, the temperature of the field sample must be entered if required. ♦ If there is no temperature compensator feature, the sample must be heated to ± 5 °C (10 °F) of the calibration sample temperature.
3	The test sample must be checked for moisture content. ♦ If moisture is present, the percentage determined must be subtracted from the apparent asphalt cement percentage as indicated by the nuclear method. ♦ Alternately, the sample may be dried to a constant weight in an oven at 110 ± 5 °C (230 ± 10 °F), thereby nullifying the need for a moisture correction.
4	Place the sample in the gauge and follow the manufacturer's instructions to obtain sample counts.
5	♦ Determine the apparent asphalt cement content and correct for moisture (if needed). ♦ Note that accuracy and precision are increased with longer count times.

Section 11
Standardization

All nuclear devices are subject to long-term aging of the radioactive source, detectors and other electronic systems, which may change the relationship between count rate and asphalt cement content. Because of this aging, new calibration curves must be run a minimum of once a year. Changes in the surroundings of the asphalt content gauge may also produce increases or decreases in count rate.

In order to minimize these effects, background counts must be taken daily and the gauges must be kept out of the proximity of water or other hydrogenous substances.

The following calibration tests are to be performed according to the manufacturer's instructions as indicated:

Stability Test

Must be performed at least once every two weeks during continuous operation and before using the gauge if more than four days have passed since the gauge was last used.

If the stability test fails, the surrounding conditions must be evaluated for causes.

A passing stability test must be done before using the gauge.

A log of all stability tests results must be maintained for each gauge.

Drift Test

Must be performed at least every 30 days during the gauge's use, and before using the gauge if 30 days have passed since the gauge was last used.

A passing stability test must be done prior to performing the drift test.

The gauge must be left in the 'power on' condition between the stability and drift test.

A passing drift test must be done before any sample testing is performed with the gauge.

A log of all drift test results must be maintained for each gauge.

Background (or Standard) Test

Must be performed at least daily, for 16 minutes, before testing samples.

A log of all background test results must be maintained for each gauge.

Section 12
Report

The report must include:

- Make, model, and serial number of the equipment
- Name of the operator
- Project identification data and date
- Identification of the asphalt cement and aggregate materials
- Type of materials and specified asphalt content
- Calibration date and daily checks
- Count rate for each sample and the corrected asphalt content, moisture content
- Weight of the sample, method of sampling and method of compaction.