



DETERMINING MAXIMUM SPECIFIC GRAVITY OF HOT MIX ASPHALT (HMA) MIXTURES

SCOPE

This test method is intended to determine the maximum specific gravity (G_{mm}) of HMA paving mixtures, commonly referred to as Rice specific gravity. This method uses a flask pycnometer and is based on Iowa Test Method 510 and AASHTO procedure T209. Instructions for the use of a metal bowl type pycnometer are also included.

REFERENCED DOCUMENTS

AASHTO T209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

[IM 357](#) Preparation of Bituminous Mix Sample for Test Specimens

Iowa Test Method 510 Method of Test for Determining Maximum Specific Gravity of Bituminous Paving Mixtures Using a Flask Pycnometer

APPARATUS

- Balance 10,000-gram minimum capacity and capable of weighing to the nearest 0.1 gram
- Pycnometer (four-liter, thick-walled glass Erlenmeyer flask without side discharge nozzle, with top surface of opening ground plane and smooth, and with rubber stopper hose connection)
- Mechanical vibratory device designed to firmly hold the pycnometer while vibrating.
- Vacuum pump or water aspirator for evacuating air from the pycnometer
- Manometer for measuring absolute pressure - **NOTE:** The manometer must not be connected to the vacuum tube coming from the pump, but is to be connected to the pycnometer through a separate tube.
- Thermometers, ASTM 15F (30 to 180°F) [ASTM 15C (-2 to 80°C)], softening point and a general purpose – of suitable range – with graduations every 0.5°F (0.2°C). Electronic thermometric devices meeting or exceeding these requirements may also be used.
- Large, flat, weighing pan about 16 in. x 24 in. x 2 3/4 in. (400 mm x 600 mm x 70 mm) with one end formed in the shape of a chute, for cooling and weighing the sample and for transferring the sample into the pycnometer.
- Glass 4 in. x 4 in. (100 mm x 100 mm) cover plate for accurate filling of pycnometer flask
- Scoop, spatula or trowel, and bulb syringe
- Elevated water container, with gravity discharge valve and tubing, of sufficient capacity to conduct a complete test

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- Funnel for transferring sample from weighing pan into the pycnometer
 - Equipment meeting AASHTO T209 will also be considered acceptable, however the weigh in water method shall not be used.

PROCEDURE

Pycnometer Calibration

Calibration of the pycnometer will be performed prior to being put in service. Pycnometer calibration will be performed by accurately determining the weight of water at $77 \pm 0.5^{\circ}\text{F}$ ($25 \pm 0.2^{\circ}\text{C}$) required to fill it. Accurate filling of the flask pycnometer may be ensured by the use of the cover plate. A calibration table may be produced by filling the pycnometer with water at 72°F and at 82°F (22.2°C and 27.8°C).

The following notes apply to both the Erlenmeyer flask apparatus and the alternate equipment meeting AASHTO T209.

NOTE: It is recommended that the calibration of the pycnometer be confirmed at least once a week or when a correlation problem exists.

NOTE: Cover plate and flask pycnometer combinations are not interchangeable. The cover plate used for calibration should also be used for routine testing. If a different cover plate is used, however, the calibrated mass (weight) used in G_{mm} determinations must be appropriately adjusted by the difference in mass (weight) between the original cover plate and its replacement.

Test Procedure

1. Obtain and transfer to the large, flat pan a test sample weighing between 2,000 and 2,500 grams by following the procedure in [IM 357](#).
2. The ignition oven and G_{mm} sample portions of the field sample are normally taken first and the gyratory density samples obtained from the remainder. When there is insufficient material in the sample for all the required tests, additional material may be obtained by re-heating and re-mixing density specimens, or the sample may be obtained solely from density specimens. Results obtained with density specimen material must be so identified on the report.

NOTE: Heat the density specimens only long enough to allow the specimens to be broken up and thoroughly mixed, using care not to overheat.

3. Separate the particles of the warmed sample so that the conglomerates of fine aggregate particles are not larger than 1/4 in. (6 mm). Use care not to fracture the aggregate particles. Discard any fractured particles found. Allow to cool to room temperature.
4. If using the flask pycnometer, add about 2 1/2 in. (60 mm) of water at about the same temperature as the sample to the calibrated pycnometer. Tare the pycnometer and water.

Transfer the sample into the pycnometer. Determine the sample weight by weighing the pycnometer to the nearest 0.1 gram. Alternately, the sample weight may be determined by weighing the large, flat pan and sample contents to the nearest 0.1 gram, transferring the sample to the calibrated pycnometer, then weighing the empty pan and determining the difference.

If using the metal bowl type pycnometer it is not required that water be added to the pycnometer prior to placing the sample in the pycnometer and the sample weight may be determined by weighing the pycnometer empty and weighing it again after the sample has been added and determining the difference.

5. If necessary, add water to cover the sample. Remove any loosely trapped air by stirring, being sure to avoid the loss of any sample.
6. Fill the flask pycnometer to about 6 in. (150 mm) from the top with water at the same temperature as that already present.

NOTE: Water may be pulled into the vacuum pump if the pycnometer is filled too high.

NOTE: The general-purpose thermometer or thermometric device, which has been calibrated with the ASTM 15F (15C) thermometer, may be used to determine temperatures for routine testing. The ASTM 15F (15C) thermometer must be used for determining temperatures when calibrating the pycnometer and for referee testing. If the thermometric device is calibrated and traceable to NIST standards it may be used in place of the ASTM thermometer.

7. Insert rubber stopper, or, if using a metal bowl type pycnometer, place the transparent plastic lid on the bowl, assure a proper seal and connect vacuum hose. Apply the vacuum necessary to attain between 1.0 in. and 1.2 in. (25 mm and 30 mm) of mercury (H_g) absolute pressure, as measured by a manometer, to the pycnometer contents for 15 minutes. During the vacuum period agitate the pycnometer and contents using a mechanical vibratory device. This will facilitate the removal of gas bubbles trapped in the mix and on the interior surface of the pycnometer.
 8. Slowly release the vacuum and remove the vacuum apparatus from the pycnometer and fill with water to the top of the pycnometer. Allow the water filled pycnometer to stand 10 minutes
 9. Tip the flask pycnometer slightly and use a glass cover plate and bulb syringe to add water until the pycnometer is completely full and no air bubbles are present. If using a metal bowl type pycnometer, place the vented metal lid on the bowl and assure that water escapes through the vent indicating that all air bubbles have been expelled.
 10. Dry the outside of the pycnometer and glass plate or top with a clean cloth, chamois or paper towel, and weigh to the nearest 0.1 gram. Immediately after weighing, remove the glass plate or top and determine the temperature of the water to the nearest 0.5°F (0.2°C) with the general purpose thermometer or thermometric device.
 11. Pour off water and dispose of sample.
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CALCULATIONS

$$G_{mm} = \frac{W \times R}{W + W_1 - W_2}$$

Where: W = Weight of sample, g

W_1 = Weight of pycnometer filled with water at test temperature, g. (This value must be determined anytime the test temperature changes from the calibration temperature by more than $\pm 0.5^\circ\text{F}$ (0.2°C)).

W_2 = Weight of pycnometer filled with water and sample, g

R = Correction multiplier obtained from Table 2

$$R = \frac{d_t}{0.99707}$$

Where: d_t = density of water at test temperature, g/cc

0.99707 = density of water at 77°F (25°C), g/cc

Note: If the temperature of the water in the pycnometer at the completion of the test is less than 72°F (22.2°C) or greater than 82°F (27.8°C) compensation for the expansion of the asphalt must be included in the calculations as shown in AASHTO T209.