

## ND T 209 - THEORETICAL MAXIMUM SPECIFIC GRAVITY AND DENSITY OF HOT MIX ASPHALT

Conduct this procedure according to ND T 209.

The AASHTO standard test procedure specifies flasks are agitated for  $15 \pm 2$  minutes and, after agitation, the flasks are immersed in water for  $10 \pm 1$  minutes. The NDDOT modification specifies flasks to be agitated for 15 minutes  $\pm$  30 seconds and, after agitation, the flasks are immersed in water for 10 minutes  $\pm$  30 seconds.

AASHTO allows for a wetting agent such as Aerosol OT to facilitate the release of entrapped air. NDDOT does not allow any wetting agent.

Consult the current edition of AASHTO for procedure in its entirety and equipment specification details.

### SCOPE

This test determines the theoretical maximum specific gravity and density of uncompacted bituminous paving mixtures at 77°F (25°C).

### REFERENCED DOCUMENTS

NDDOT 5, Sampling and Splitting Field Verification Hot Mix Asphalt (HMA) Samples

AASHTO T 209, Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt

### APPARATUS

Vacuum container

Volumetric flasks,\* two at 2000 mL each

Vacuum gage, capable of measuring 30 mm Hg (4 kPa)

Vacuum pump, capable of evacuating air from a flask to a pressure of 30 mm Hg (4 kPa)

Thermometers

Water bath

Orbital shaker

Pan

Glass cover plate

Balance

\*Flasks shall be sufficiently strong to withstand a partial vacuum and shall have a cover fitted with a rubber stopper with a hose connection. A smooth

piece of fine wire mesh covering the hose opening will minimize the possibility of loss of fine material. The top surfaces of the flasks shall be smooth and substantially plane.

## TEST SPECIMEN

Material used for this test procedure may be obtained from behind the paver as outlined in NDDOT 5, or from laboratory prepared samples. An approximate 2000 g sample of hot mix asphalt is needed.

## PROCEDURE

Weigh and record all masses to the nearest tenth of a gram on SFN 7925.

Cure laboratory prepared samples in an oven at  $275 \pm 9^\circ\text{F}$  ( $135 \pm 5^\circ\text{C}$ ) for a minimum of 2 hours or until constant\*\* mass is achieved.

Paving mixtures that have not been prepared in a laboratory with oven-dried aggregates shall be dried to constant\*\* mass at a temperature of  $221 \pm 9^\circ\text{F}$  ( $105 \pm 5^\circ\text{C}$ ).

\*\*Constant is defined as when mass repeats within 0.1%.

Determine the weight of each flask full of distilled water, with a matching glass plate, at a temperature of  $77 \pm 1^\circ\text{F}$  ( $25 \pm 0.5^\circ\text{C}$ ).

To obtain the weight, overfill the flask so the water is convexed above the brim. Then slide the cover plate over the brim of the flask. The flask should be free of any air bubbles. Dry the outside. Weigh and record.

Spread in a large pan. Cool to room temperature. While this mixture is cooling, periodically, carefully separate the particles so that clumps of the fine aggregate portion are no larger than 1/4" (6.3 mm).

Place the flask on a scale and tare the scale. Place half of the hot mix asphalt sample in the flask and weigh. After recording weight, add sufficient distilled water that is at approximately  $77^\circ\text{F}$  to cover the sample completely. Repeat this process with the remaining half of the material using the second flask.

Remove entrapped air by subjecting the contents of both flasks to a partial vacuum of 30 mm Hg (4 kPa). Maintain the partial vacuum and agitate the containers and contents with an orbital shaker that is set at 225 to 250 rpm with a 3/4" throw for 15 minutes  $\pm$  30 seconds.

Note: Problems have been encountered with some mixes clumping and forming a mass instead of freely moving particles during the 15-minute agitation period. If this happens, it is probable that all the

entrapped air will not be removed. (This is more likely to happen when the sample is not adequately cooled before putting it in the flasks). The mix will have to be broken up before agitation continues. This can be done by:

- Shutting off the vacuum to the flask while keeping the vacuum pump running.
- Maintain all hose connections.
- Vigorously hand shake the flask until the sample is free moving.
- Take care so vacuum is not lost to the flask.
- Return the flask to the shaker and turn on the vacuum to the flask.
- Do not stop the timer through this procedure.

After removing from orbital shaker, release the vacuum by increasing the pressure at a rate not to exceed 60 mm Hg (8 kPa) per second. Remove flasks from shaker. Fill flasks (*slightly overfill*) with distilled water that is at a temperature of  $77 \pm 1^\circ\text{F}$  ( $25 \pm 0.5^\circ\text{C}$ ). Place in a water bath at a temperature of  $77 \pm 2^\circ\text{F}$  ( $25 \pm 1^\circ\text{C}$ ) for 10 minutes  $\pm$  30 seconds.

Remove from water bath, slide the glass cover plate over the flask, and remove from the bath. Dry the outside. Weigh and record.

#### Flask Calibration

Determine the weight of each flask full of distilled water, with a matching glass plate, at a temperature of  $77 \pm 1^\circ\text{F}$  ( $25 \pm 0.5^\circ\text{C}$ ).

To obtain the weight, overfill the flask so the water is convexed above the brim. Then slide the cover plate over the brim of the flask. The flask should be free of any air bubbles. Dry the outside. Weigh and record.

## **CALCULATIONS**

The theoretical maximum specific gravity weight in air is calculated as follows:

$$\textit{Theoretical Maximum Specific Gravity} = A/(A + D - E)$$

*A = mass of oven-dry sample in air*

*D = mass of container filled with water at 77°F (25°C)*

*E = mass of container filled with sample and water at 77°F (25°C)*

The difference in maximum specific gravity results of two properly conducted tests on the same sample shall not exceed 0.011. Use the average of the results from the two flasks of the passing test for the final maximum specific gravity.

If the difference exceeds 0.011, rerun the test.

## **NOTES**

The specified cure time in the oven is a minimum of two hours for laboratory prepared specimens only. Plant produced materials should not be cured since absorption takes place during production.

## **CALIBRATION**

A calibration check of the equipment should be performed annually as a minimum, or whenever damage or repair occurs.