

Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)

AASHTO R 28-12 (R2016)

6. APPARATUS

6.1. A test system consists of a pressure vessel, pressure-controlling devices, temperature-controlling devices, pressure- and temperature-measuring devices, and a temperature-recording device (Figure 1)

6.1.1. *Pressure Vessel* – A stainless steel pressure vessel designed to operate at 2.1 ± 0.1 MPa between 90 and 110°C with interior dimensions adequate to hold 10 stainless steel pans and a pan holder.

The pressure vessel shall contain a pan holder capable of holding 10 stainless steel pans in a horizontal (level) position such that the asphalt binder film thickness in the bottom of the pans does not vary by more than 0.5 mm across any diameter of the pan. The holder shall be designed for easy insertion and removal from the vessel when the holder, pans, and asphalt binder are at the test temperature. A schematic showing the vessel, pan holder and pans, and specifying the dimensional requirements is shown in Figure 2.....

Note 1 – The vessel may be a separate unit to be placed in a forced draft oven for conditioning the asphalt binders or an integral part of the temperature control system (for example, by direct heating of the vessel or by surrounding the vessel with a permanently affixed heating unit, forced air oven, or liquid bath).

6.1.2. *Pressure-Controlling Devices:*

6.1.2.1. A pressure release valve that prevents pressure in the vessel from exceeding 2.2 MPa during the aging procedure.....

6.1.2.2. A pressure regulator capable of controlling the pressure within the vessel to ± 1 percent, and with a capacity adequate to reduce the pressure from the source of compressed air so that the pressure within the loaded pressure vessel is maintained at 2.1 ± 0.1 MPa during the practice.....

6.1.2.3. A slow release bleed valve that allows the pressure in the vessel at the completion of the conditioning procedure to be reduced at an approximately linear rate from 2.1 MPa to local atmospheric pressure within 9 ± 1 min.....

6.1.3. *Temperature-Controlling Devices* – A temperature control device as described in Section 6.1.3.1. or Section 6.1.3.2. for maintaining the temperature during the aging procedure at all points within the pressure vessel at the aging temperature $\pm 0.5^\circ\text{C}$ and a digital proportional controller for maintaining the specified temperature control.....

6.1.3.1. A forced-draft oven or fluid bath capable of
 (1) bringing the loaded unpressurized vessel to the desired conditioning temperature $\pm 0.5^\circ\text{C}$, as recorded by the Resistance Thermal Detector (RTD) inside the vessel within 2 h.....
 and (2) maintaining the temperature at all points within the pressure vessel at the aging temperature $\pm 0.5^\circ\text{C}$

The oven shall have sufficiently large interior dimensions to allow forced air to freely circulate within the oven and around the pressure vessel when the vessel is placed in the oven. The oven shall contain a stand or shelf that supports the loaded pressure vessel in a level position above the lower surface of the oven (i.e., maintains the film thickness in the aging pans within the specified tolerance)

Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)

AASHTO R 28-12 (R2016)

6.1.3.2. A pressure vessel with integral temperature control system that is capable of
 (1) brining the loaded pressure vessel to the desired conditioning temperature $\pm 0.5^{\circ}\text{C}$ within 2 h, as recorded by the RTD inside the loaded pressure vessel.....
 and (2) maintaining the temperature at all points within the pressure vessel at the aging temperature $\pm 0.5^{\circ}\text{C}$

6.1.4. *Temperature- and Pressure-Measuring Devices:*

6.1.4.1. A platinum RTD accurate to the nearest 0.1°C and meeting DIN Standard 43760 (Class A), or equal, for measuring temperature inside the pressure vessel.....

The RTD shall be calibrated as an integral unit with its respective meter or electronic circuitry.....

Note 2 – The RTD or thermistor and its meter may be calibrated by the manufacturer or a commercial vendor. Verification can be obtained by comparing the output from the RTD with an NIST traceable ASTM 94C mercury-in-glass thermometer in accordance with ASTM E 220. A stirred fluid bath is suitable for calibrating the thermal detector. Select a partial immersion mercury-in-glass thermometer with an appropriate range and place the thermal detector and the thermometer in the stirred water bath. Fasten the detector to the glass thermometer with a rubber band or rubber O-ring. Allow the bath, detector, and thermometer to come to thermal equilibrium and record the temperature of the glass thermometer and the readout from the thermal detector. The temperature in the bath shall not change by more than $0.1^{\circ}\text{C}/\text{min}$ during the calibration process.

6.1.4.2. *Temperature-Recording Device* – A strip chart recorder or other data acquisition system capable of recording temperature throughout the test to 0.1°C . As an alternative, an electronic device capable of reporting maximum and minimum temperatures (accurate to $\pm 0.1^{\circ}\text{C}$) may be used.....

6.1.4.3. A pressure gauge capable of measuring the pressure in the pressure vessel to within ± 1 percent during the test.....

6.2. *Stainless Steel Pans* – 10 standard stainless steel pans with an inside diameter of 140 mm and 9.5 mm deep with a flat bottom. Pans shall be made of stainless steel and should have a metal thickness of approximately 0.635 mm.....

6.3. *Balance* – A balance conforming to the requirements of M 231, Class G 2.....

6.4. *Vacuum Oven* – A vacuum oven capable of maintaining a temperature up to 180°C with an accuracy of $\pm 0.5^{\circ}\text{C}$ and a vacuum of 1.0 kPa absolute.....

6.5. *Vacuum System* – A vacuum system capable of generating and maintaining pressures below 15 kPa absolute. Suitable vacuum systems include a vacuum pump, air aspirator, or house vacuum system.....

7. MATERIALS

7.1. Commercial bottled air or equivalent.....

Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)

AASHTO R 28-12 (R2016)

9. CALIBRATION AND STANDARDIZATION

9.1. *Temperature Detector* – Verify the calibration of the RTD to 0.1°C at least every 6 months using a calibrated thermometer.....

9.2. *Pressure Gauge* – Standardize the pressure gauge to an accuracy of 1 percent at least every 6 months.....

Note 3 – The pressure gauge is usually calibrated by the manufacturer or a commercial calibration service. Verification of the continued stability of the pressure gauge within the specified requirements should be done periodically by checking against another certified pressure measurement device.

9.3. To determine the optimum temperature at which to apply pressure to the pressure vessel, several tests should be made.....

With the vessel loaded with pan rack and empty pans, increase the temperature to aging temperature.....

When the temperature inside the pressure vessel is within 10°C of the aging temperature, apply an air pressure of 2.1 ± 0.1 MPa.....

Record the temperature increase when the pressure is applied.....

Perform the procedure at least 3 time and use the average temperature increase to establish the temperature at which to apply pressure to the vessel for performing the aging procedure.....

10. PROCEDURE

10.1. Condition the asphalt binder in accordance with T 240 (RTFOT)

10.2. After combining the RTFOT residue into a single container and blending as specified in T 240; (1) pour the hot residue directly into the stainless steel pans for immediate conditioning in the PAV _____ or (2) pour the residue into the stainless steel pans, cover and set aside for conditioning at a later time.....

or (3) allow the residue to cool in the single container for conditioning at a later time.....

If the residue is allowed to cool in the pans, reheat the pans and residue to the conditioning temperature.....

If the residue is stored in a single container, heat the residue, stir gently, and pour the heated residue into the pans.....

10.3. Place the pan holder inside the pressure vessel.....

If an oven is used, place the pressure vessel inside the oven.....

If an integrated temperature control pressure vessel is used, turn on the heater. Select an aging temperature and preheat the pressure vessel to the aging temperature selected.....

Note 4 – If conditioning asphalt binders for conformance to M 320, select the appropriate aging temperature from Table 1 of M 320.

Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)

AASHTO R 28-12 (R2016)

Note 5 – Preheating the vessel 10 to 15°C above the conditioning temperature can be used to reduce the drop in PAV temperature during the loading process and minimize the time required to stabilize the system, after loading, to attain the required temperature.

Note 6 – Aging temperature in the PAV is selected to account for different climatic regions. Temperature in excess of approximately 115°C can change the chemistry of asphalt binders aged in accelerated tests and should be avoided.

10.4. Place the stainless steel pan on a balance and add 50 ± 0.5 g of asphalt binder to the pan. This amount will yield approximately a 3.2 mm thick film of asphalt binder.....

Note 7 – The mass change is not measured as part of this procedure. Mass change is not meaningful because the asphalt binder absorbs air as a result of pressurization. Any gain in mass as a result of oxidation is masked by the air absorbed by the asphalt binder as a result of the pressurization.

10.5. If the vessel is preheated to other than the desired aging temperature, reset the temperature control on the heating device to the aging temperature.....

10.6. Place the filled pans in the pan holder.....

(Pans containing asphalt binders from different sources and grades may be placed in the pressure vessel during a single test.)

Place the pan holder with filled pans inside the pressure vessel, and close the pressure vessel.....

10.7. If an oven is used, place the loaded and closed pressure vessel in the oven.....

10.8. Connect the temperature transducer line and the air pressure supply line to the loaded pressure vessel’s external connections.....

10.9. Perform the operations described in Sections 10.5. to 10.8. as quickly as possible to avoid cooling of the vessel and pan holder.....

10.10. Wait until the temperature inside the pressure vessel is within 20°C of the aging temperature, apply an air pressure of 2.1 ± 0.1 MPa, and then start timing the test.....

If the temperature inside the vessel has not reached the desired temperature for applying pressure within 2 h of loading the pan holders and pans, discontinue the procedure and discard the asphalt samples.....

Note 8 – Pressures in excess of 2.1 MPa do not substantially increase the rate of aging. Therefore, higher pressures are not warranted.

Note 9 – Once pressurized, the temperature inside the pressure vessel will equilibrate rapidly. The time under pressure, not to include any preheating time at ambient pressure, is the aging time. Relatively little aging occurs at ambient pressure during the time that the vessel is being reheated to test temperature, given that asphalt binder residue under test has been exposed to 163°C in the RTFOT.

10.11. Maintain the temperature and air pressure inside the pressure vessel for 20 h ± 10 min.....

10.12. At the end of the 20 h test period, slowly begin reducing the internal pressure of the PAV, using the air pressure bleed valve.....

Adjust the bleed valve to an opening that requires 9 ± 1 min to equalize the internal and external pressures on the PAV, thus avoiding excessive bubbling and foaming of the asphalt binder.....

Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)

AASHTO R 28-12 (R2016)

During this process it may be necessary to adjust the setting of the needle valve as the pressure drops in order to maintain an approximate linear rate of pressure decrease. Do not include the pressure release and equalization time as part of the 20 h aging period..... _____

10.13. If the temperature indicated by the temperature-recording device falls above or below the target aging temperature $\pm 0.5^{\circ}\text{C}$ for more than 60 min during the 20 h aging period, declare the test invalid and discard the material..... _____

10.14. Remove the pan holder and pans from the PAV, and place the stainless steel pans in an oven set at a minimum temperature for a minimum time until sufficiently fluid to pour..... _____

Stir the residue in the pan gently to assist in the removal of air bubbles..... _____

If the binder is conditioned in multiple pans, pour the hot residue into a single container. Scrape residue remaining in the pans into the container, followed by gentle stirring to blend the residue..... _____

If the sample must be heated to temperatures greater than 175°C to facilitate pouring, note the temperature and heating time in the report..... _____

Note 10 – A temperature of 163°C has been found to be suitable for many binder grades.

10.15. *Vacuum Degassing (Optional)* – Preheat the vacuum oven until it stabilizes at $170 \pm 5^{\circ}\text{C}$ _____

Follow the instructions in 10.14. except select a container of dimensions such that the depth of the residue in the container is between 15 and 40 mm..... _____

10.15.1. After the binder has been combined into a single container, immediately transfer the container to the vacuum oven and maintain the temperature in the vacuum oven at $170 \pm 5^{\circ}\text{C}$ for 15 ± 1 min, without a vacuum applied..... _____

After the 15 ± 1 min of equilibration, open the vacuum valve as rapidly as possible to reduce the pressure in the oven to 15 ± 2.5 kPa absolute..... _____

Maintain the absolute pressure in the oven at 15 ± 2.5 kPa for 30 ± 1 min..... _____

At the end of the 30 min, release the vacuum, and remove the container..... _____

If any bubbles are visible on the surface of the residue, remove them by flashing the surface of the residue with a torch or hot knife..... _____

10.16. *Correction to Gauge Reading for Elevation* – A vacuum gauge attached to the vessel indicates the difference between atmospheric pressure and the pressure in the vessel.

If the vessel is located above sea level, the gauge reading must be corrected for altitude to indicate the correct absolute pressure within the vessel..... _____

This correction is not used if the vessel is fitted with an absolute pressure gauge..... _____

Do not correct the reading for temperature for the barometric pressure reported by a weather station as this pressure is typically already corrected for elevation..... _____

10.16.1. Correct the vacuum gauge to sea level using a correction factor in accordance with Table 1..... _____

If an absolute pressure gauge is used, no correction is needed..... _____

Note 11 – At sea level, standard atmospheric pressure is 29.92 in.Hg, 760 mmHg, 1.013 kPa, or 14.7 psi.

Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)

AASHTO R 28-12 (R2016)

Note 12 – If the material foams over the lip of the container during the degassing, reduce the rate at which the vacuum is release until foaming ceases.

10.17. From the residue generated in Sections 10.14. or 10.15., prepare test specimens directly from the residue in the container, pour the residue from the container (Section 10.14.) to subdivide into smaller containers for future testing, or set the container aside for future testing....._____

COMMENTS