Temperature Restrictions during Binder Storage, Mix Production

Primary Purpose: to avoid damaging the asphalt binder by excessively aging it during storage and mixing

Potential Damage:

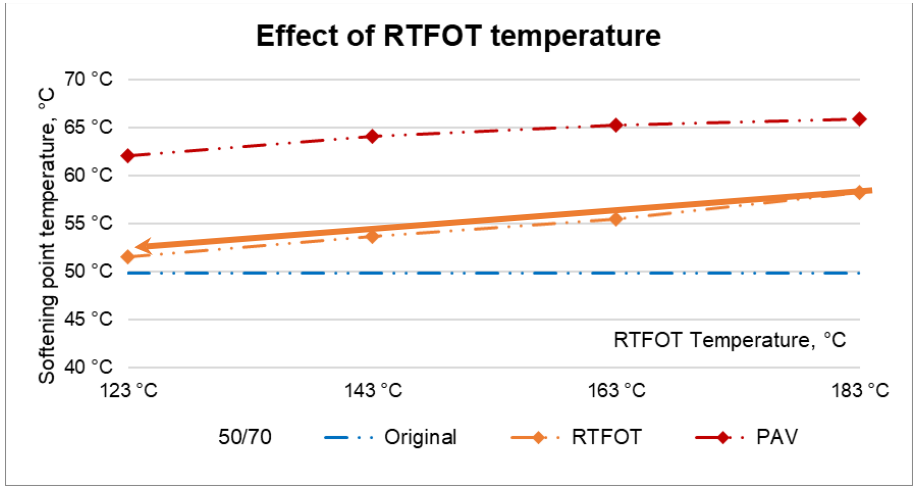
- Embrittlement at intermediate and low temperatures, leading to premature cracking and raveling
- Damage to polymer chains, potentially affecting the resistance of the binder to cracking

Other Issues:

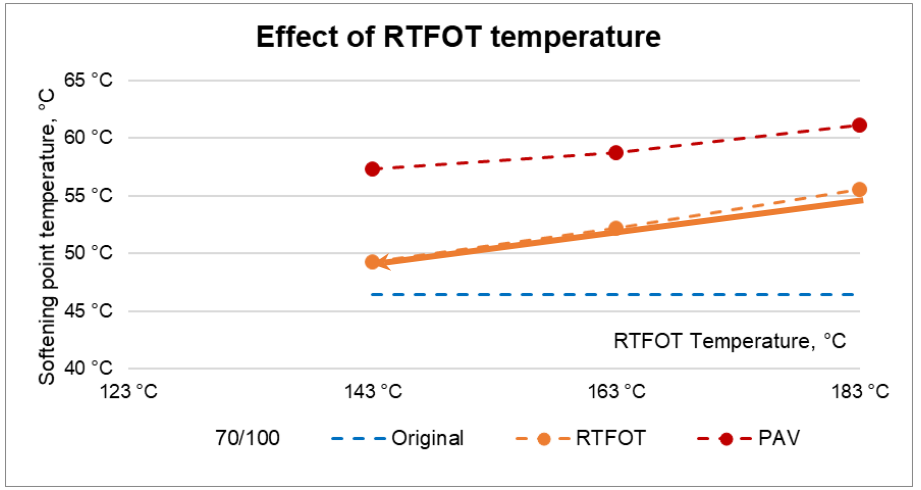
- Modified binders, especially High Polymer, can continue to crosslink when stored at excessive temperatures, making them more viscous and difficult to handle

Effect on softening point temperature

- Overall increasing RTFOT temperature increased change of properties
  - Increase by +3°C with a 20°C increase in RTFOT temperature
- After PAV, somehow less difference vs. RTFOT temperature
  - 1-2°C increase each 20°C RTFOT temperature



50/70 bitumen



70/100 bitumen

Polymer Modified Binders

- We recently tested samples of PG76-22 and HP to see how DSR qualities at high temperature were affected by RTFO temperature
  - RTFO conditioning at 163, 175 and 185°C (325, 347 and 365°F)
- Shear modulus (G*) increased with increasing conditioning temperature for all samples
- Other parameters (δ, MSCR criteria) didn’t consistently change with increased conditioning temperature

NCHRP 648-Mixing and Compaction Temperatures of Asphalt Binders in Hot-Mix Asphalt (West, Watson, Turner & Casola)

- “This report identifies improved test methods for determining laboratory mixing and compaction temperatures of modified and unmodified asphalt binders.”
  - Included a draft AASHTO Standard for “Steady Shear Flow and Phase Angle Methods.”
- Research included evaluation of aging using “Smoke and Emissions Protocol (SEP)”, where:
  - 50 gram samples were aged for two hours at 130, 150, 170 and 190°C
  - During aging, mass and opacity of emissions were measured, samples were tested to measure binder qualities related to performance

General Trends after SEP aging at different temperatures

- Opacity, mass loss increased with increasing temperature
- Increased stiffness at intermediate temperature
- Inconsistent effect on m-value (low temperature relaxation)

FDOT Specifications-Temperatures

- **320-3.3 Asphalt Binder**: Meet the following requirements: 320-3.3.1 Transportation: Deliver the asphalt binder to the asphalt plant at a **temperature not to exceed 370°F**, and equip the transport tanks with sampling and temperature sensing devices meeting the requirements of 300-3.2.
- **320-3.3.2 Storage**: Equip asphalt binder storage tanks to heat the liquid asphalt binder to the temperatures required for the various mixtures. Heat the material in such a manner that no flame comes in contact with the binder. Heat or insulate all pipe lines and fittings. Use a circulating system of adequate size to ensure proper and continuous circulation during the entire operating period. Locate a thermometer, reading from 200 to 400°F, either in the storage tank or in the asphalt binder feed line. Maintain the asphalt binder in storage within a range of **230 to 370°F** in advance of mixing operations.
- **320-6.3 Mix Temperature:** Produce the mixture with a temperature within the master range as defined in Table 320-2.

Table 320-2	
Mix Temperature Master Range Tolerance	
Location	Acceptable Temperature Tolerance
Plant	Mixing Temperature ±30 F
Roadway (mix in truck)	Compaction Temperature ±30°F
Roadway (mix in windrow)	Compaction Temperature +30°F, -40°F

Table 320-3	
Mix Temperature Tolerance from Verified Mix Design	
Any Single Measurement	±25°F

Sampling of agencies

Agency	Temperature Requirement(s)
NYSDOT	Binder ≤ 350°F, Mix delivery ≤ 325°F
Iowa DOT	Binder: 260° - 330°F, Mix production: 225° - 330°F
Alabama DOT, LaDOTD	Mixture ≤ 350°F
Arizona DOT	Mixture ≤ 325°F (PG TR+)
Texas DOT	Binder ≤ 350°F, Mixture-table below

Table 13
Maximum Production Temperature

High-Temperature Binder Grade[1]	Maximum Production Temperature
PG 64	325°F
PG 70	335°F
PG 76	345°F

1. The high-temperature binder grade refers to the high-temperature grade of the virgin asphalt binder used to produce the mixture.

The Shell Bitumen Handbook (6th Ed.)

- For Shell Cariphalte® Polymer Modified Bitumen:
  - Short-term storage (3-4 days): around 165-175°C (329-347°F)
  - Long-term storage (up to 2 weeks): below 140-160°C (284-320°F)
  - Very long-term storage: below 100°C (212°F)

Table 10.1 Recommended pumping, mixing, and compaction temperatures[2]

Asphalt Pavement Environment Council Best Practices

Typical Asphalt Binder Temperatures

Binder Grade	HMA Plant Asphalt Tank		HMA Plant Mixing	
	Storage Temperature (°F)		Temperature (°F)	
	Range	Midpoint	Range	Midpoint
PG 46-28 PG 46-34 PG 46-40	260–290 260–290 260–290	275 275 275	240–295 240–295 240–295	264 264 264
PG 52-28	260–295	278	240–300	270
PG 70-28	295–320	308	275–325	300
PG 76-22 PG 76-28	315–330 310–325	322 318	285–335 280–330	310 305
PG 82-22	315–335	325	290–340	315

Use mid-point temperature for test strip construction.

Best Management Practices to Minimize Emissions During HMA Construction, EC 101, Asphalt Pavement Environmental Council (National Asphalt Pavement Association, Asphalt Institute, and State Asphalt Pavement Associations), April 2000.