# Performance Graded Asphalt Binders, Storage Temperatures, and Effects on Mixing & Compaction

Analyzing temperature impacts on asphalt binder performance

# Performance Graded Asphalt Binders

# What Are PG Asphalt Binders?

### PG Binder Temperature Ratings

PG binders are rated by their ability to resist rutting at **high temperatures** and cracking at **low temperatures.**

### Performance-Based Classification

The PG system classifies binders based on real temperature and loading conditions, improving pavement durability. 100-year Climatical Database.

### Modified Asphalt Binders

Modified binders with polymers enhance elasticity and resistance to stripping and fatigue cracking.

### Importance for Production

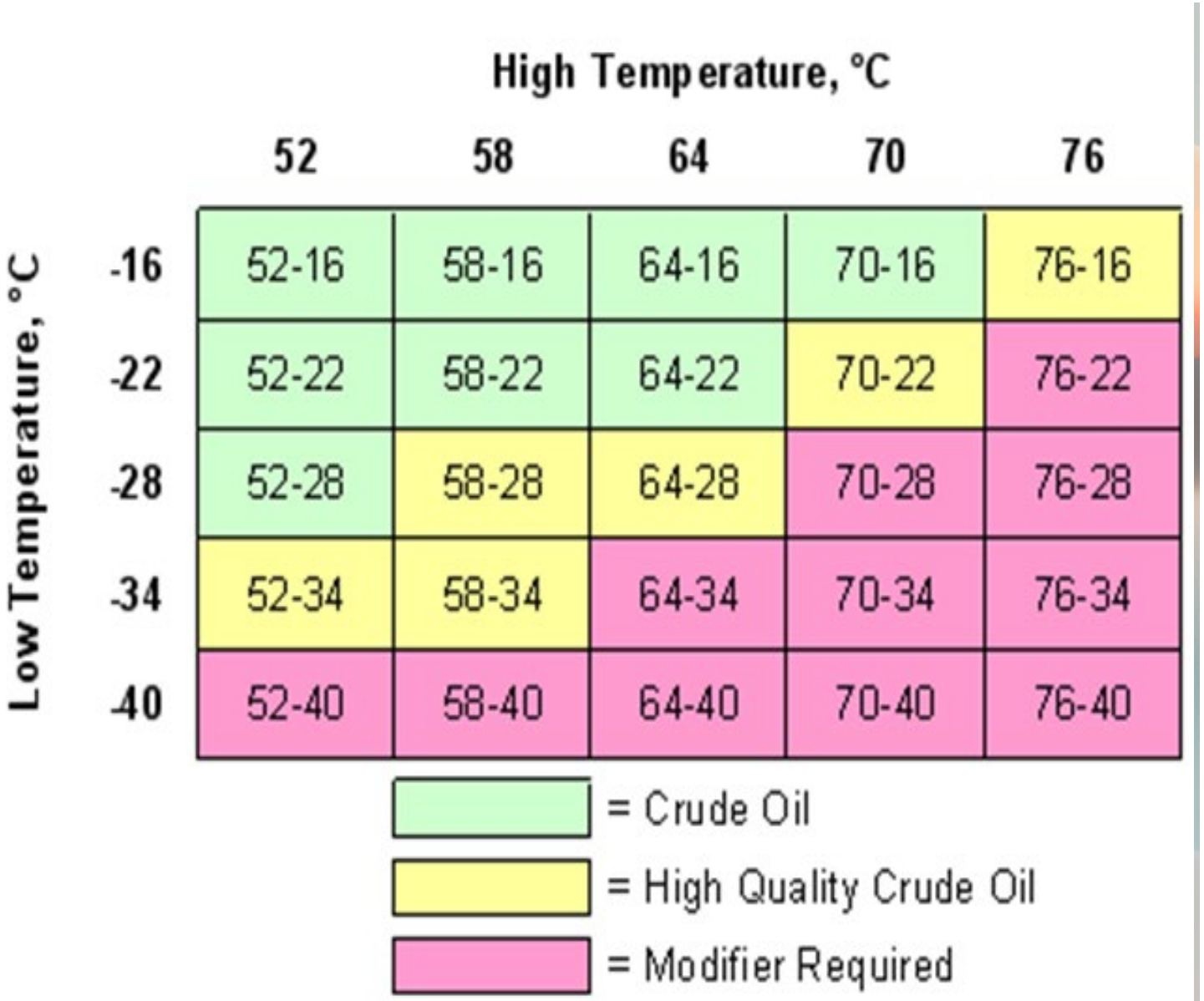
Understanding PG binders guides mix designers and paving crews for optimal mixing and compaction.

# Performance Grades

| Max. Design Temp. | PG 46 | | | PG 52 | | | | | | | PG 58 | | | | | PG 64 | | | | | | PG 70 | | | | | | PG 76 | | | | | PG 82 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min. Design Temp. | -34 | -40 | -46 | -10 | -16 | -22 | -28 | -34 | -40 | -46 | -16 | -22 | -28 | -34 | -40 | -10 | -16 | -22 | -28 | -34 | -40 | -10 | -16 | -22 | -28 | -34 | -40 | -10 | -16 | -22 | -28 | -34 | -10 | -16 | -22 | -28 | -34 |
| **Original** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ≥230 °C | **Flash Point** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ≤ 3 Pa-s @ 135 °C | **Rotational Viscosity** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ≥ 1.00 kPa | **DSR G*/sin δ** (Dynamic Shear Rheometer) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 46 | | | 52 | | | | | | | 58 | | | | | 64 | | | | | | 70 | | | | | | 76 | | | | | 82 | | | | |
| **(Rolling Thin Film Oven) RTFO, Mass Change ≤ 1.00%** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ≥ 2.20 kPa | **DSR G*/sin δ** (Dynamic Shear Rheometer) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 46 | | | 52 | | | | | | | 58 | | | | | 64 | | | | | | 70 | | | | | | 76 | | | | | 82 | | | | |
| **(Pressure Aging Vessel) PAV** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 hours, 2.10 MPa | 90 | | | 90 | | | | | | | 100 | | | | | 100 | | | | | | 100(110) | | | | | | 100(110) | | | | | 100(110) | | | | |
| ≤ 5000 kPa | **DSR G*sin δ** (Dynamic Shear Rheometer) Intermediate Temp. = [( Max. + Min.)/2] + 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 10 | 7 | 4 | 25 | 22 | 19 | 16 | 13 | 10 | 7 | 25 | 22 | 19 | 16 | 13 | 31 | 28 | 25 | 22 | 19 | 16 | 34 | 31 | 28 | 25 | 22 | 19 | 37 | 34 | 31 | 28 | 25 | 40 | 37 | 34 | 31 | 28 |
| S ≤ 300 MPa<br>m ≥ 0.300 | **BBR S (creep stiffness) & m-value** (Bending Beam Rheometer) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | -24 | -30 | -36 | 0 | -6 | -12 | -18 | -24 | -30 | -36 | -6 | -12 | -18 | -24 | -30 | 0 | -6 | -12 | -18 | -24 | -30 | 0 | -6 | -12 | -18 | -24 | -30 | 0 | -6 | -12 | -18 | -24 | 0 | -6 | -12 | -18 | -24 |
| If BBR m-value ≥ 0.300 and creep stiffness is between 300 and 600, the Direct Tension failure strain requirement can be used in lieu of the creep stiffness requirement. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\varepsilon_f \geq 1.00\%$ | **DTT** (Direct Tension Tester) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | -24 | -30 | -36 | 0 | -6 | -12 | -18 | -24 | -30 | -36 | -6 | -12 | -18 | -24 | -30 | 0 | -6 | -12 | -18 | -24 | -30 | 0 | -6 | -12 | -18 | -24 | -30 | 0 | -6 | -12 | -18 | -24 | 0 | -6 | -12 | -18 | -24 |

# Key Points

- Lower the values = Softer the binder = Thinner Viscosity (PG46-34)
- Higher the values = Stiffer the binder = Thicker Viscosity (PG76-22)
- Additives can be used to stiffen or soften binders. Rule of 92°
- All Additives have recommended storage temperatures – Talk with your suppliers.



# Proper Storage Temperatures

# Maintaining Correct Storage Temperatures

### Optimal Temperature Range

Unmodified PG binders store between 275-325°F; modified binders might require higher temperatures to maintain desired viscosity.

### Risks of Improper Temperature

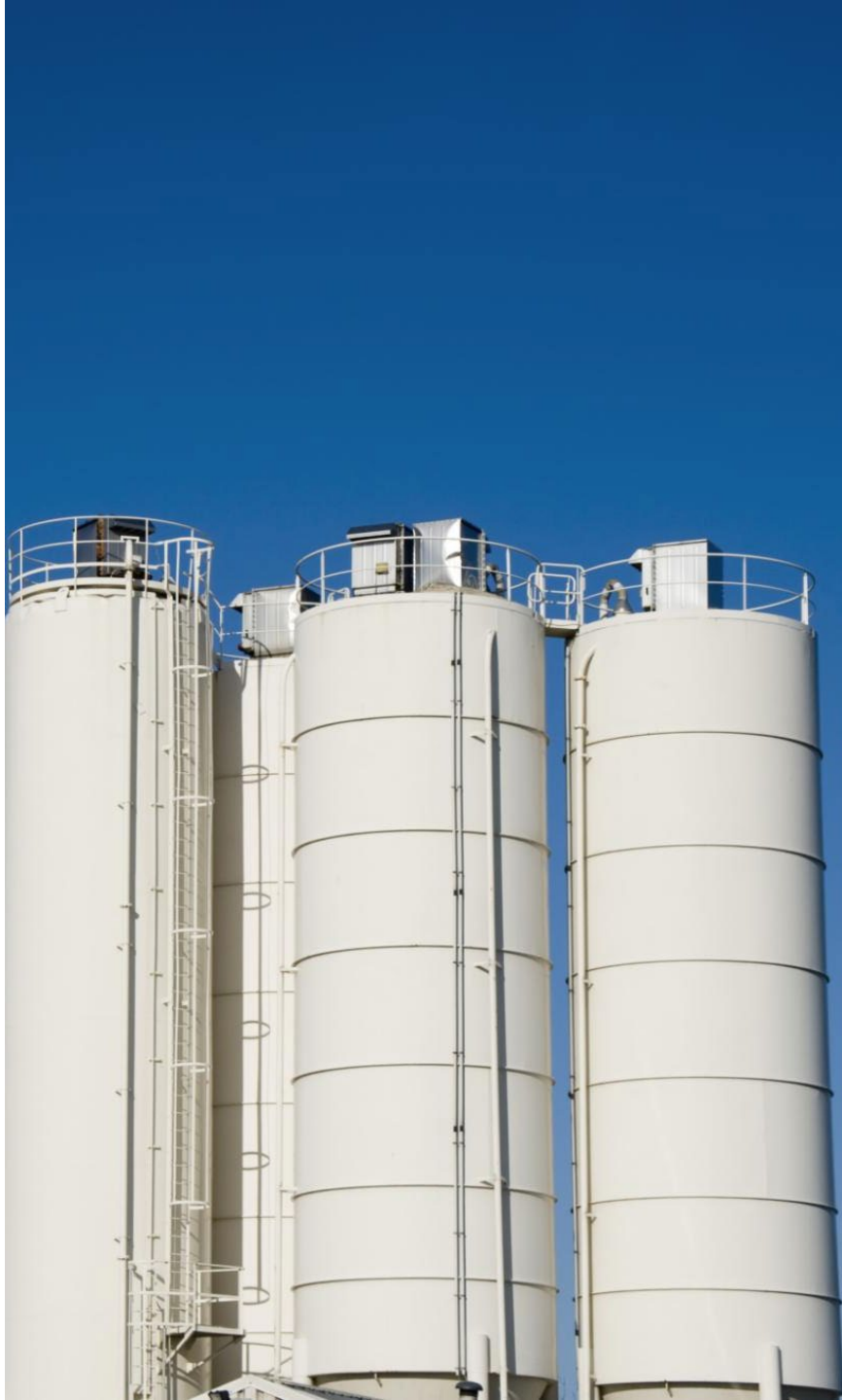
Overheating causes oxidation and brittleness; low temperatures hinder pumping and mixing operations. Leads to volume loss of material due to Mass Loss.

### Preventing Thermal Stratification

Continuous circulation prevents temperature layers in tanks, ensuring accurate viscosity measurements.

### Routine System Maintenance

Regular calibration of sensors and monitoring of insulation ensures consistent storage temperatures.



# Additives Proper Handling

- Every additive has recommended storage temperatures
- Some additives are not compatible together.
- When incorporating additives – make sure adequate mixing time is allowed.

    Tank Agitators vs. In-Line Blenders

- **Rule of Thumb -** "If you are seeing smoke, it is too hot"

# Effects on Mixing

# How Temperature Influences Asphalt Mixing

### Effect of Low Binder Temperature

Low binder temperature increases viscosity, preventing adequate aggregate coating and causing weak spots in asphalt mix.

### Effect of High Binder Temperature

Excessive heat causes binder hardening and brittleness, leading to cracking and loss of polymer additives.

### Optimal Binder Temperature Benefits

Maintaining optimal temperature ensures uniform coating, stable mix, and longer-lasting asphalt pavements.

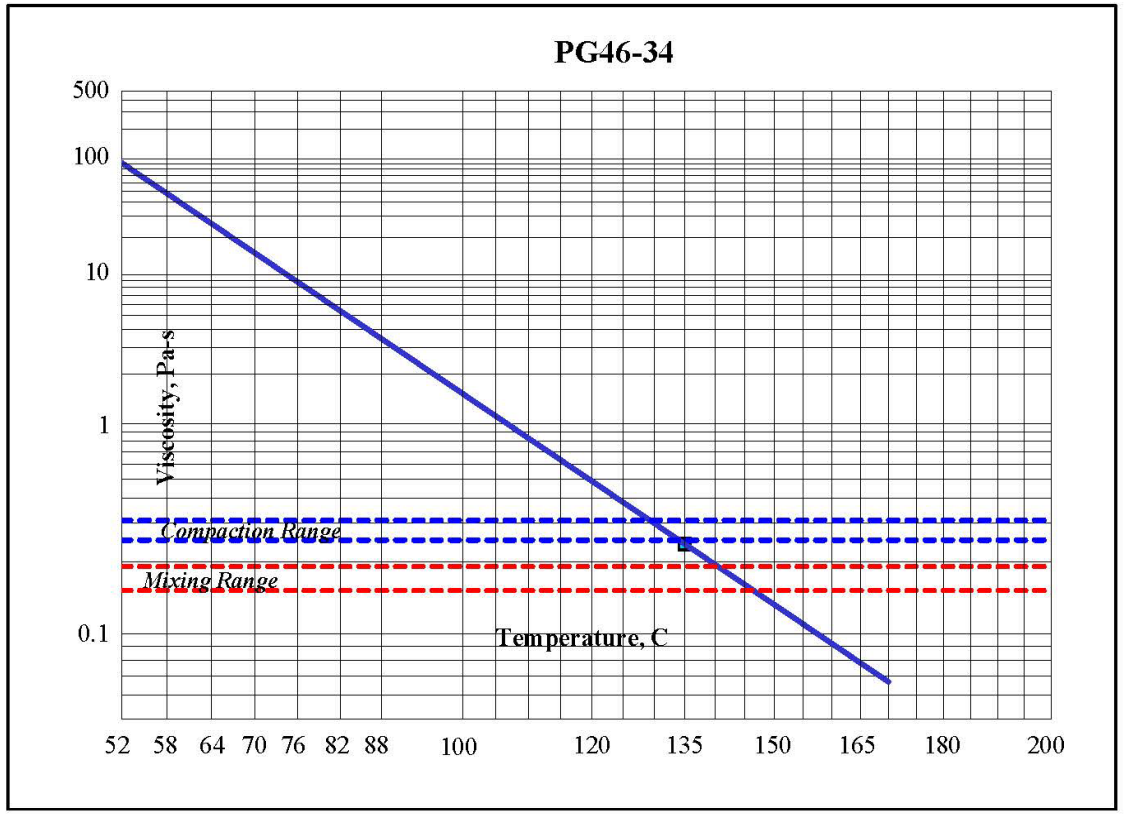
*Paint a wall with freezing cold paint or Super-Hot Paint?*

| | | | | | | |
|---|---|---|---|---|---|---|
| Binder | **PG46-34** | | | | | |
| Temp (C) | Viscosity (cp) | Mixing Temperature Range, C | 141 | - | 146 | (285 - 294°I |
| **135** | **240** | Compaction Temperature Range, C | 129 | - | 134 | (264 - 273°I |

| | |
|---|---|
| Specific Gravity | **1.0144** |

DSR (*Do not enter if using two RV measurements*)

| | |
|---|---|
| Temperature, C | **46** |
| G*/sin δ (kPa) | **1.875** |



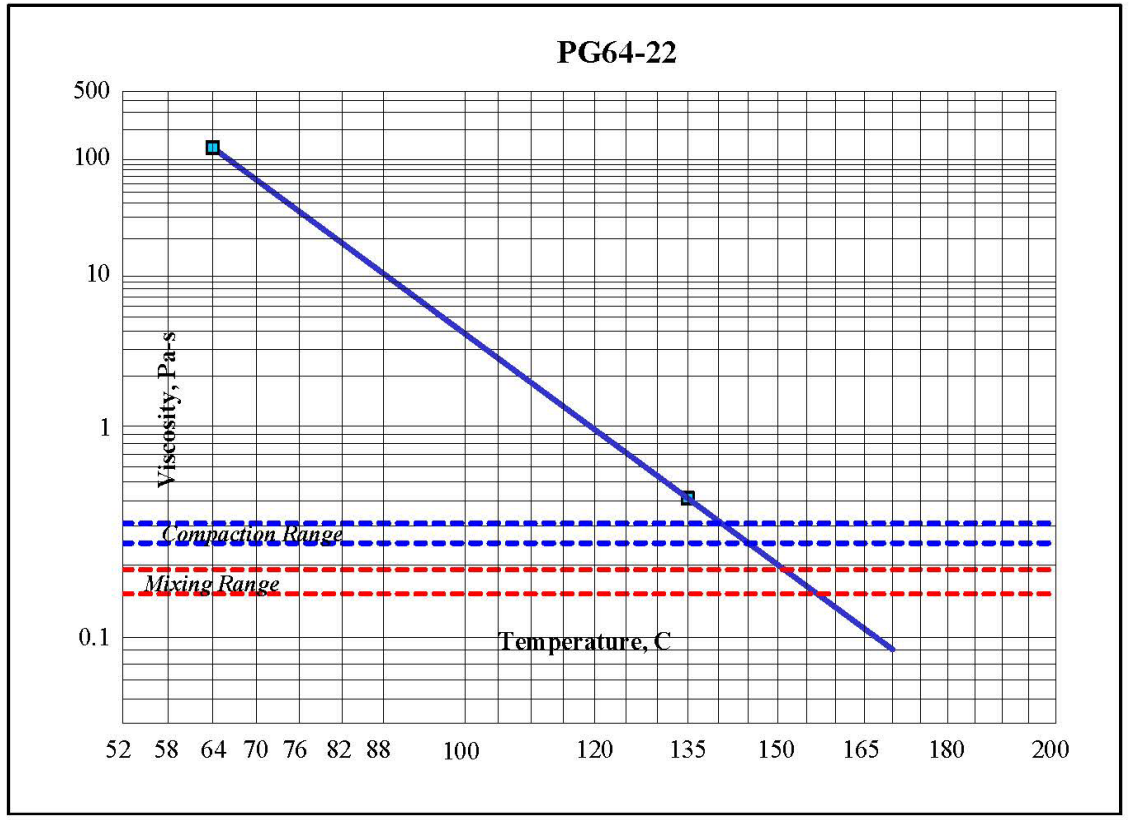
Binder **PG64-22**

| Temp (C) | Viscosity (cp) |
|---|---|
| **135** | **410** |

Mixing Temperature Range, C 151 - 157 (303 - 314°I
Compaction Temperature Range, C 141 - 145 (285 - 293°I

Specific Gravity **1.0264**

DSR (*Do not enter if using two RV measurements*)
Temperature, C **64**
G*/sin δ (kPa) **1.316**



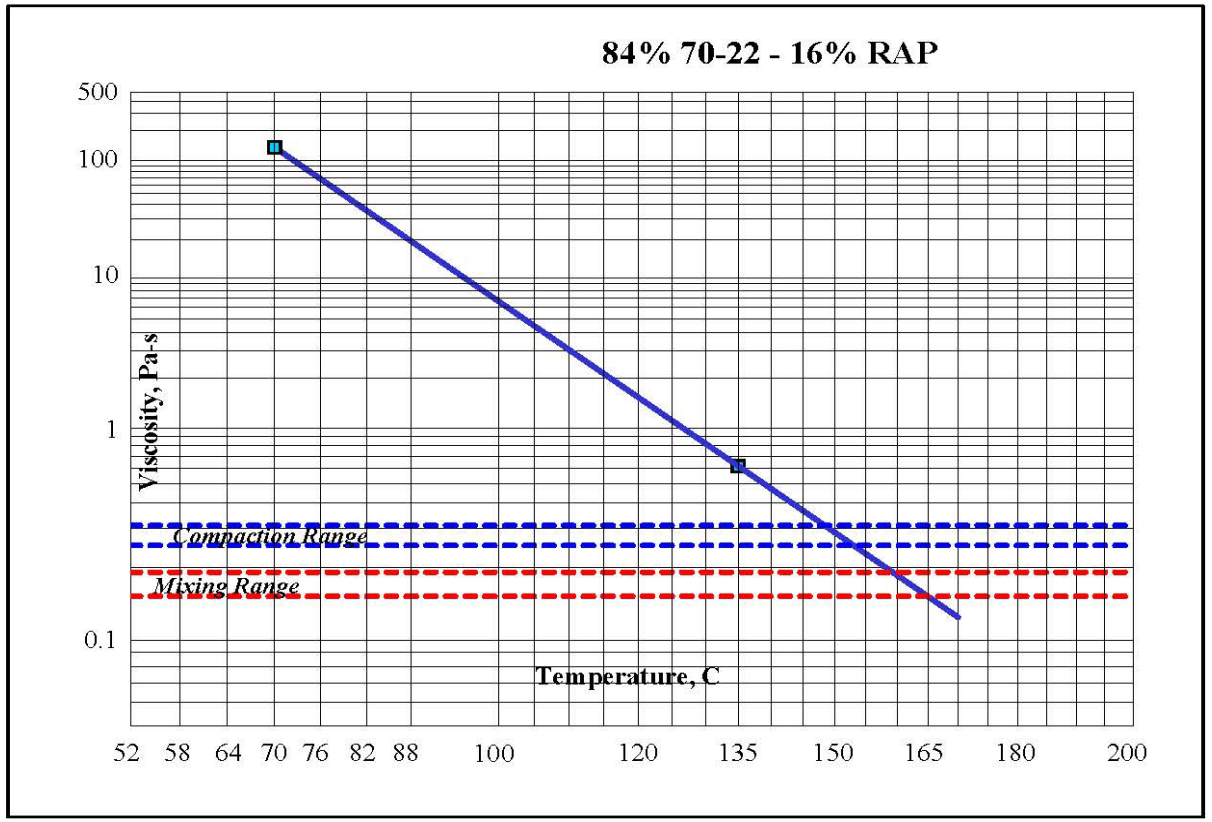
| | | | | | |
|---|---|---|---|---|---|
| Binder | **84% 70-22 - 16% RAP** | | | | |
| Temp (C) | Viscosity (cp) | Mixing Temperature Range, C | 159 | - 165 | (318 - 329°F) |
| **135** | **618** | Compaction Temperature Range, C | 148 | - 153 | (298 - 307°F) |

Specific Gravity **1.0436**

DSR (*Do not enter if using two RV measurements*)

Temperature, C **70**

G*/sin δ (kPa) **1.3536**



# Effects on Compaction

# Temperature Impacts on Achieving Proper Compaction

### Temperature's Role in Compaction

Binder temperature controls asphalt viscosity, crucial for aggregate rearrangement during compaction.

### Consequences of Low Temperature

Low temperatures cause binder stiffening, leading to inadequate density and higher air voids.

### Effects of Excessive Heat

Excessive heat makes mix tender, causing shoving and displacement during roller compaction. Loss of integrity of chemical – will not perform as designed.

### Importance of Temperature Control

Maintaining optimal temperature ensures proper compaction, durability, and extends pavement life.

# Conclusion

# Summary of Key Principles

### Performance Graded Binders

Performance graded binders enable pavements to resist temperature stresses and traffic loads, ensuring durability.

### Proper Storage Temperatures

Maintaining correct storage temperatures protects binder quality and prevents premature aging in asphalt production.

### Controlled Mixing Temperatures

Controlling binder temperature during mixing ensures uniform coating and stable asphalt mix consistency.

### Optimal Compaction Temperatures

Proper compaction temperature management achieves required pavement density and long-term durability.

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