Utilizing Smokeless Asphalt Technology to Improve Performance and Reduce Emissions

PAPA Environmental Seminar
March 15, 2026
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AGENDA

1. What is Smokeless Asphalt?
2. Smokeless Asphalt Improving Performance
3. Smokeless Asphalt Reducing Emissions
4. Case Studies
5. Current Initiatives
6. Next Steps

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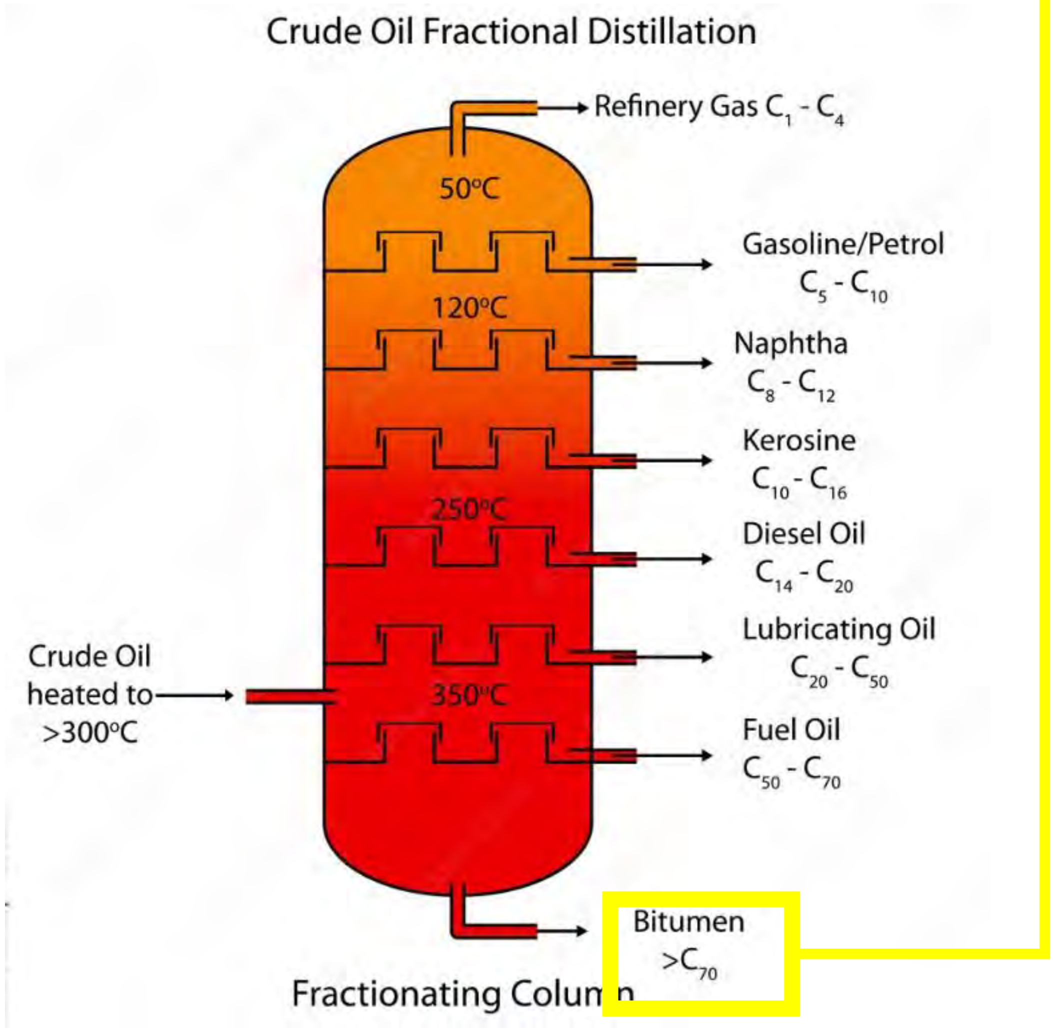
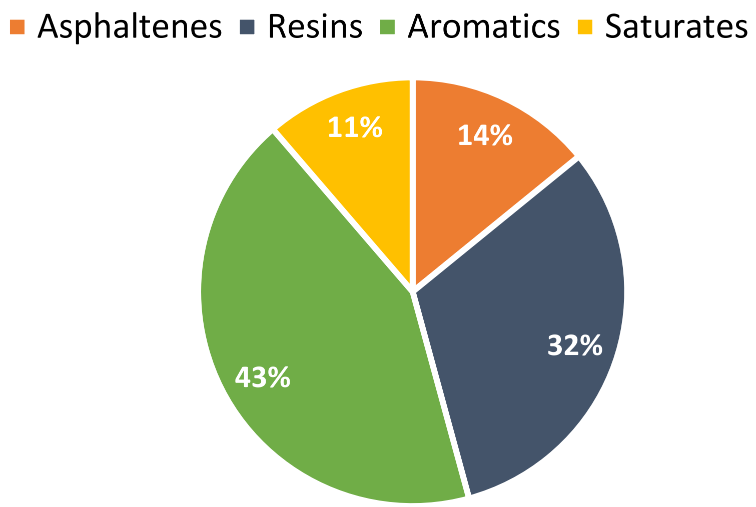
What is Smokeless Asphalt?

Asphalt





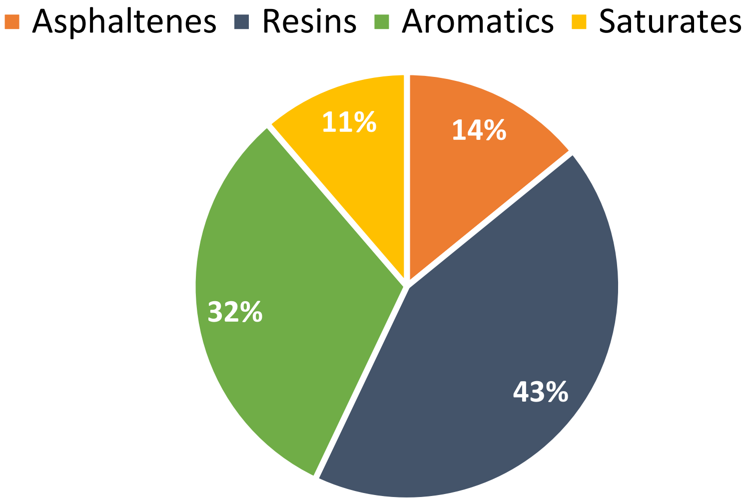
Asphaltenes – Govern stiffness, viscosity, stability performance

Resins – Act as peptizing agent in asphalt colloid

Aromatics – Solvent phase, provide flexibility performance

Saturates – Excess can worsen low temperature performance

Asphalt



Asphaltenes – Govern stiffness, viscosity, stability performance

Resins – Act as peptizing agent in asphalt colloid →

Aromatics – Solvent phase, provide flexibility performance →

Saturates – Excess can worsen low temperature performance →

Steam
Particulate Matter
Combustion Byproducts
Volatile Organic Compounds
Organic Aerosols

Temperature

Paving longer-lasting roads and reducing smoke are not mutually exclusive

Evolution of Smokeless Asphalt in Pennsylvania

1

2005–2006

Prior to 2005, use of HMA was commonplace, mix designs under SUPERPAVE system being explored, initial trials of additives to reduce temperature (WMA)

2

2015–2016

SUPERPAVE design and evaluation methods are commonplace, WMA has been widely implemented – WMA mandate issued by PENNDOT

3

2025–2026

Currently used as a facilitator of other environmental efforts, additional RAP, improved compact, what is left? What is the next jump?

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Longer Lasting Pavements

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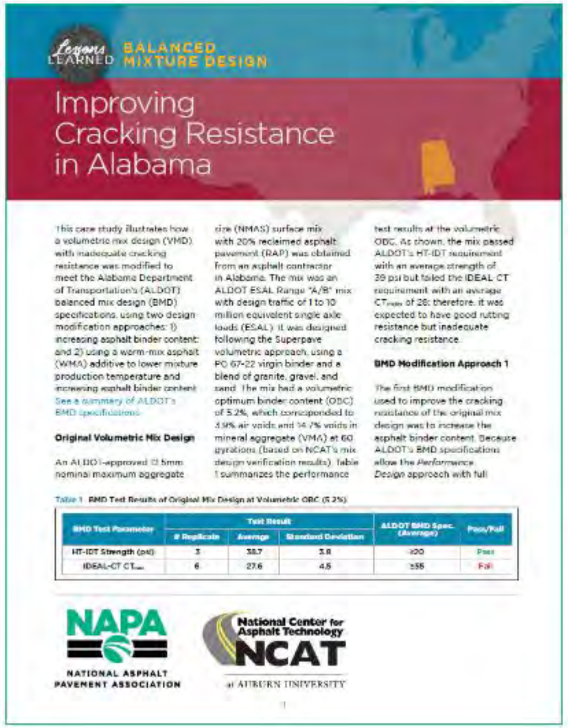
Improving Performance

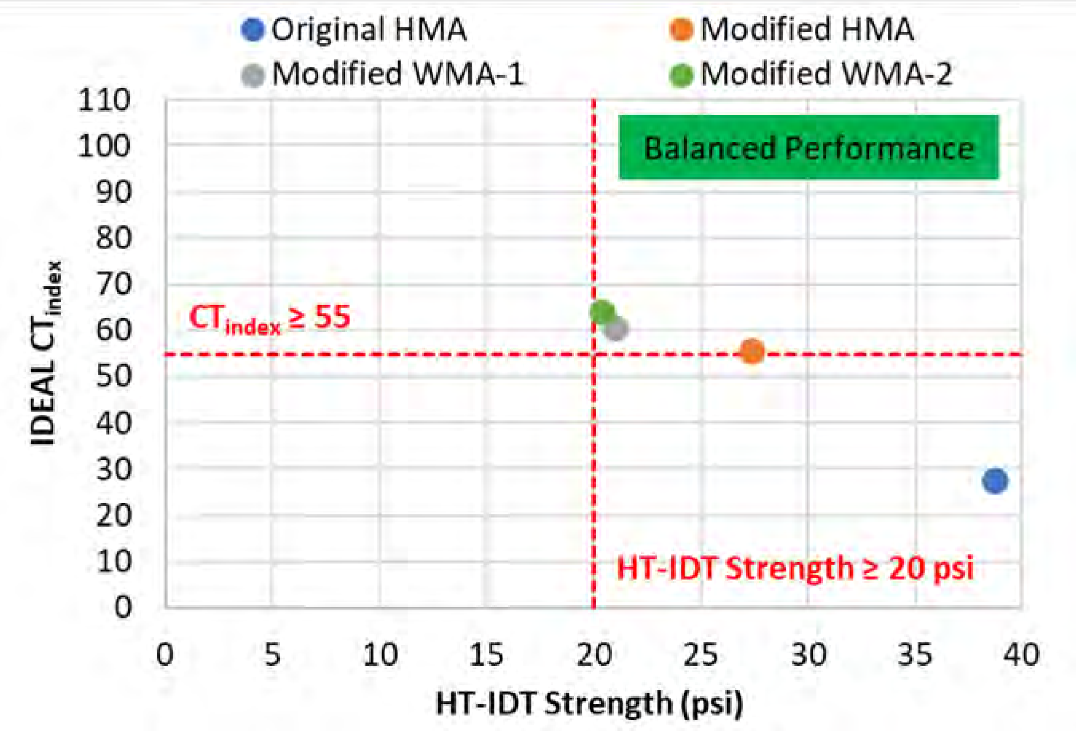
Performance and Compatibility

Reduce	Stripping
Improve	Rut Resistance
Increase	Crack Resistance
Reduce	Binder Oxidation & Improve Delta Tc
Increase	Density & Improve Compaction

Improved BMD – NCAT WMA Case Study

Mix Property	Original HMA	Modified HMA	Modified WMA-1	Modified WMA-2
Total Binder Content (%)	5.2	5.9	5.6	5.6
RAP Content (%)	20	20	20	20
Additive	-	-	WMA-1	WMA-2
RAP Binder Replacement (%)	21%	19%	20%	20%
Virgin Binder Content (%)	4.1	4.8	4.5	4.5
Virgin Binder Grade	PG 67-22	PG 67-22	PG 67-22	PG 67-22
Air Voids (%)	3.9	1.8	2.7	2.7
VMA (%)	14.7	14.5	14.5	14.5
VFA (%)	74	87	81	81





https://asphaltpavement.org/expertise/engineering/resources/bmd-resource-guide/bmd-tools

Experimental Ranges of Evotherm WMA - NCHRP Report 843

- Lift thickness ranges from 1.25 inches to 3.75 inches. NMAS range from 9.5 to 19-mm.
- Unmodified binders (PG 58-28, PG 64-22, PG 52-34).
- Modified Binders (PG 64-28, PG 70-22, PG 70-28, PG 76-28, PG 76-22).
- RAP ranges from 0 to 30%.
- With 1% lime and without lime.
- With additional LAS and without.
- Aggregate type - limestone, gravel, quartzite, granite, siliceous, crushed river rock, slag, etc.
- Binder content from 4.2 to 7%.
- Traffic from 650 to 160,000 AADT.

“Network” Level Analysis – Long Term Performance (NCHRP 843)

Mix Type	Average WP Longitudinal Cracking (ft/200 ft)	Average Transverse Cracking (ft/200 ft)	Average Rutting (in)
HMA	59.1	80.4	0.10
Chemical WMA	47.6	64.0	0.09
% Improvement	24.2%	25.6%	~0%

15 Projects in 11 States
Average distress after **average pavement life of 6 years**.
Mixture Production $\Delta T = 40°F$

Mix Type	Average WP Longitudinal Cracking (ft/200 ft)	Average Transverse Cracking (ft/200 ft)	Average Rutting (in)
HMA	5.6	31.6	0.04
Foaming	11.5	32.2	0.04
% Improvement	-105.9%	-2.1%	~0%

10 Projects in 9 States
Average distress after **average pavement life of 5.2 years**
Mixture Production $\Delta T = 45.9°F$

Texas Field Performance

Mix Type	Transverse Cracking (linear ft)	Longitudinal Cracking (linear ft)	Wheel Path Fatigue Cracking (linear ft)
HMA	24	296.7	33.3
Chemical WMA	20	73.3	6.7
% Improvement	20.0%	304.5%	400.0%

3 Projects

Average distress after **average pavement life of 3.7 years**

$\Delta T = 73°F$

Estakhri, Cindy. "Laboratory and Field Performance Measurements to Support the Implementation of Warm Mix Asphalt in Texas." FHWA/TX-12/5-5597-01-1. July 2012

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-14/0-6613-1		
4. Title and Subtitle EVALUATION OF BINDER AGING AND ITS INFLUENCE IN AGING OF HOT MIX ASPHALT CONCRETE: TECHNICAL REPORT		5. Report Date Published: April 2014 6. Performing Organization Code
7. Author(s) Charles J. Glover, Guanlan Liu, Avery A. Rose, Yunwei Tong, Fan Gu, Meng Ling, Edith Arambula, Cindy Estakhri, and Robert Lytton		8. Performing Organization Report No. Report 0-6613-1
9. Performing Organization Name and Address Texas A&M Transportation Institute College Station, Texas 77843-3135		10. Work Unit No. (TRAIS) 11. Contract or Grant No. Project 0-6613
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Implementation Office 125 East 11th St. Austin, Texas 78701-2483		13. Type of Report and Period Covered Technical Report: September 2011–August 2013 14. Sponsoring Agency Code

15. Supplementary Notes
Project performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration.
Project Title: Evaluate Binder and Mixture Aging for Warm Mix Asphalt.
URL: http://tti.tamu.edu/documents/0-6613-1.pdf

16. Abstract

Warm mix asphalt (WMA) technologies, through reduced mixing and placement temperatures, have reduced fuel consumption, enhanced compaction, increased haul distances and an extended paving season. Issues of concern in WMA are binder oxidation and absorption and their impact on pavement durability. *Key future work* should combine results from this project with other recent TxDOT projects to develop a *comprehensive and fundamentals based mixture design and pavement performance prediction methodology* that accounts for climate, traffic loading, pavement structural properties, life-cycle cost analysis, and that is applicable to HMA, WMA, polymer-modified binders, and mixtures that incorporate RAP and RAS. Such an effort would be a major contribution to pavement design and is a realistic goal.

Some other key findings are: 1) absorption is directly related to aggregate void fraction, 2) WMA absorption is somewhat less than HMA absorption, 3) the DGC provides a reliable and relatively easy measure of absorption for an aggregate/binder pair, 4) standard (ASTM) methods for measuring absorption can be problematic, depending on the level of absorption, 5) binders modified using warm mix technologies were found to have similar oxidation kinetics to their base binders, 6) the overlay tester and VEC measurements were successfully used to characterize mixture fatigue, 7) mixture fatigue resistance declines with binder oxidation, a result that is omitted entirely from typical pavement design guides (e.g., the MEPDG), and 8) during the first summer of its service life, oxidative aging, curing, and absorption have a significant beneficial effect on the performance of warm mixes.

17. Key Words	18. Distribution Statement
Asphalt Oxidation Kinetics, DSR Function, Carbonyl Area, Density Gradient Column, Warm Mix Asphalt, Mixture Stiffness Gradient, Asphalt Absorption, Dynamic Mechanical Analyzer, Asphalt Specification	No restrictions. This document is available to the public through NTIS: National Technical Information Service Alexandria, Virginia 22312 http://www.ntis.gov

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	216	

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Density Matters

- 1% increase in field density increases pavement service life up to 10+%
- Annual Savings of $1.75 to $8.75 billion with a "B"
- FHWA Demonstration Project for Enhanced Durability of Asphalt Pavements through Increased In-place Pavement Density showcased that chemical WMA improved in place density or reduced effort needed to achieve required density
- Density is important – not the only thing

Aschenbrener, T., ETG Presentation, April 27, 2016
FHWA Demonstration Project for Enhanced Durability of Asphalt Pavements through Increased In-place Pavement Density, Phase 3 FHWA-HIF-20-003

▪ 2

Utilizing Smokeless Asphalt to Reduce Fugitive Emissions

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Emerging Industry Air Quality Challenges

- Plant Odors, Fumes and Emissions, & Air Quality Issues
  - Utah Air Quality Regulation for Ozone Non-Attainment Areas
  - NY Dept. of Environmental Conservation Blue Smoke Regulation
  - Michigan and Illinois EPA Region 5 Environmental Justice Action
  - City of Chicago Regulation to submit Blue Smoke Control Plans in asphalt contract bids
  - NJ Dept of Environmental Protection
  - Municipalities!!

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From Plant to Pavement

Smokeless warm mix asphalt transforms the entire paving process—starting at the plant, carrying through transport, and making a difference on the job site.

2022 Trials – FL, IL, NY, UT, VA

Particulate Emissions Devices at the Plant

One particulate analyzer placed at the load out

One particulate analyzer placed at the top of the silo

One particulate analyzer placed over the chute

APT Device

Fuel Usage Measurements

CO_2 - Stack Testing

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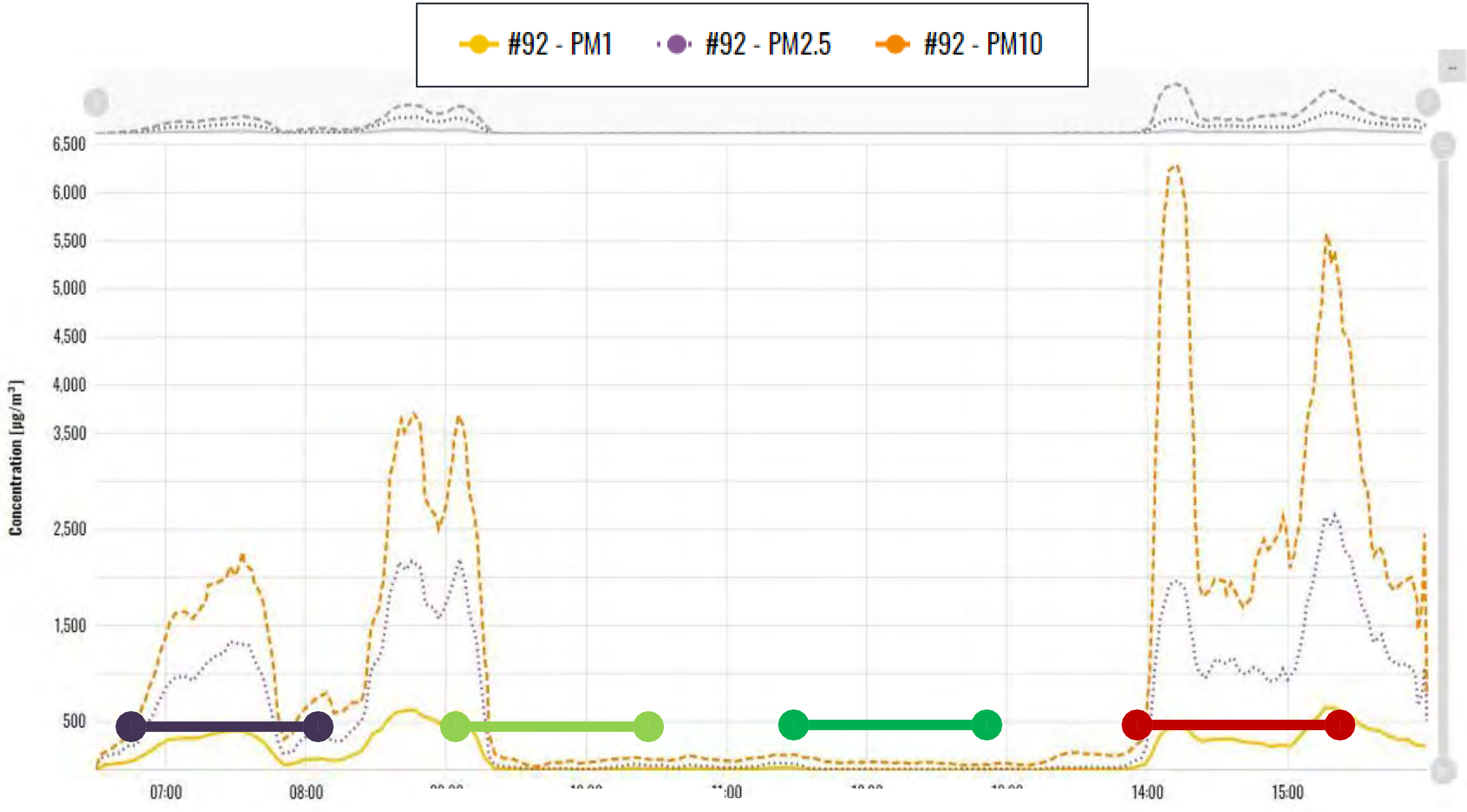
Emissions Reductions Benefits with True WMA



Run #1 AVG 305F Mix Temp

Run #2 280F AVG Mix Temp

Run #3 260F AVG Mix Temp

Run #4 325F AVG Mix Temp

APT Device

2022 Low Temperature WMA Data

Fugitive Emissions Reductions by Location (**PM10**)

Note: Average Temp Reduction 51°F-55°F

Top of Silo	Silo Loadout	Screed Operator	Center of Screed
92%	80%	88%	92%

Note: Average Reduction across the projects

2022 Low Temperature WMA Data

Fugitive Emissions Reductions by Location (**PM2.5**)

Note: Average Temp Reduction 51°F-55°F

Top of Silo	Silo Loadout	Screed Operator	Center of Screed
75%	67%	90%	87%

Note: Average Reduction across the projects

2022 Low Temperature WMA Data

Five Projects in Five States: "By the Numbers"

Temperature

55°F

Fuel

20%

CO_2

23%

Fugitive Emissions

Top of Silo (PM10)

92%

Note: Average Reduction across the projects

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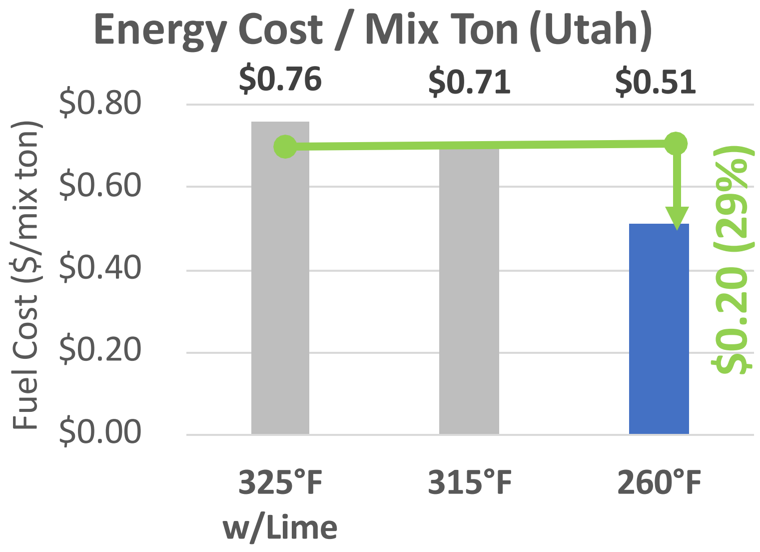
WMA PLANT FUEL CONSUMPTION 2022

Note: Natural gas fuel $3.00/MMBtu assumption

Utah Contractor

- 360 Tons/hr
- Gencor Counter Flow
- 15% RAP
- 250k Mix Tons/yr
- $50k Savings (single plant at 260°F)

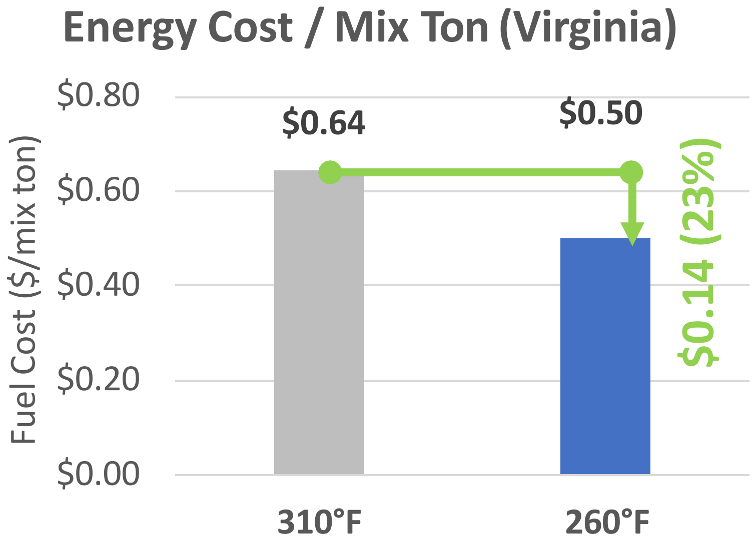
CO_2 Reduction 26.0%



Virginia Contractor

- 290 Tons/hr
- Astec Double Barrel
- 30% RAP Content
- 250k Mix Tons/yr
- $35k Savings (single plant at 260°F)

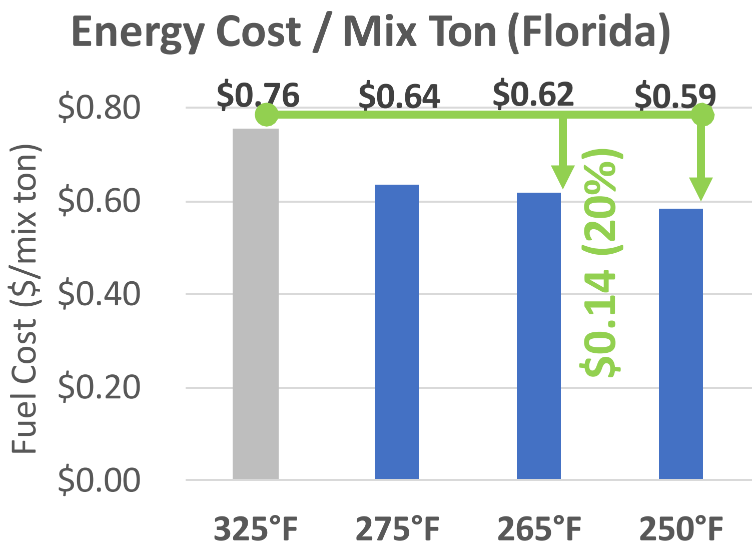
CO_2 Reduction 21.8%



Florida Contractor

- 200 Tons/hr
- Astec Double Barrel
- 40% RAP
- 150k Mix Tons/yr
- $21k Savings (single plant at 265°F)

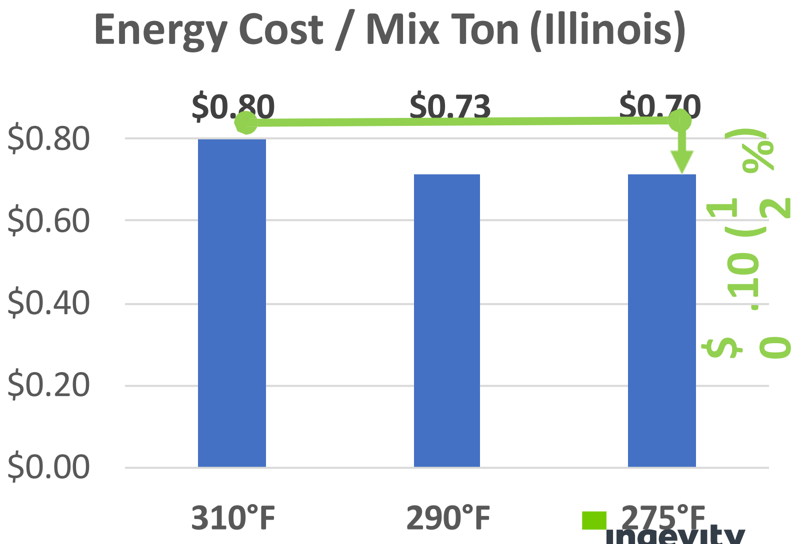
CO_2 Reduction 25.1%



Illinois Contractor

- 300 Tons/hr
- Gencor Counter Flow
- 40% RAP Content
- 350k Mix Tons/yr
- $35k Savings (single plant at 275°F)

CO_2 Reduction 14.0%



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Reduced Temperature Pilots - NY

Plant	Callanan 1	Pallette Stone	Callanan 2
Average Temperature [° F] Hot/Warm	321/261	311/282	322/291
Silo Emissions PM10 Reduction	95.3%	95.4%	63.4%
Silo Emissions PM2.5 Reduction	86.6%	79.2%	39.4%
Silo Emissions PM1 Reduction	74.7%	56.6%	31.5%

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Temperature Reduction Incentive Specifications

Minnesota Special Specification

Table 2360.2-1A
Warm Mix Asphalt Incentive Payment

Plant Mixing Temperature	Incentive Payment, percent
> 275°F	0
250°F - 275°F	2
< 250°F	4

5 Projects Completed in 2025

11 Projects Slated for 2026

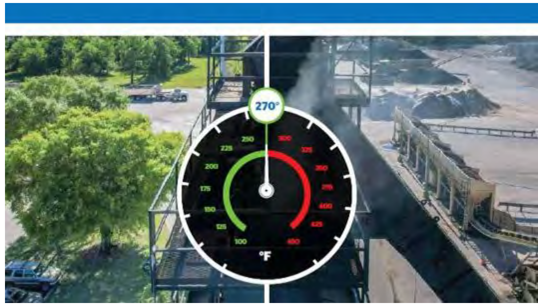
Massachusetts Special Provision

Massachusetts Department of Transportation
Superpave High Performance Surface Course

Table 458.79 – HMA Price Adjustments

Average Monthly HMA Production Temperature (degrees Fahrenheit)	Price Adjustment (dollars per ton)
>310F	None
≤ 310F	1% of unit bid price
≤ 295F	2% of unit bid price

2 Projects let in 2026
Planning to add at least 1 or 2 more



- 5

The Proof is in the Pictures

Reducing Visible Emissions with Low Production Temperatures

Standard Asphalt Mix

Warm Asphalt Mix

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CONCLUSION: Smokeless asphalt can virtually eliminate smoke and emissions and improve mix performance.

- Temp reduction of 50°F or more will significantly reduce visible emissions and odors at the plant and paver versus merely capturing the smoke at the plant
- Temp reduction is a proven, economical approach to reducing/eliminating visible emissions and odors
- Smokeless asphalt has the added benefit of helping industry meet the climate goals by reducing GHG emissions by approximately 20% or more
- Smokeless asphalt can improve mix performance and make the roads last 20-30% longer

Questions?

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