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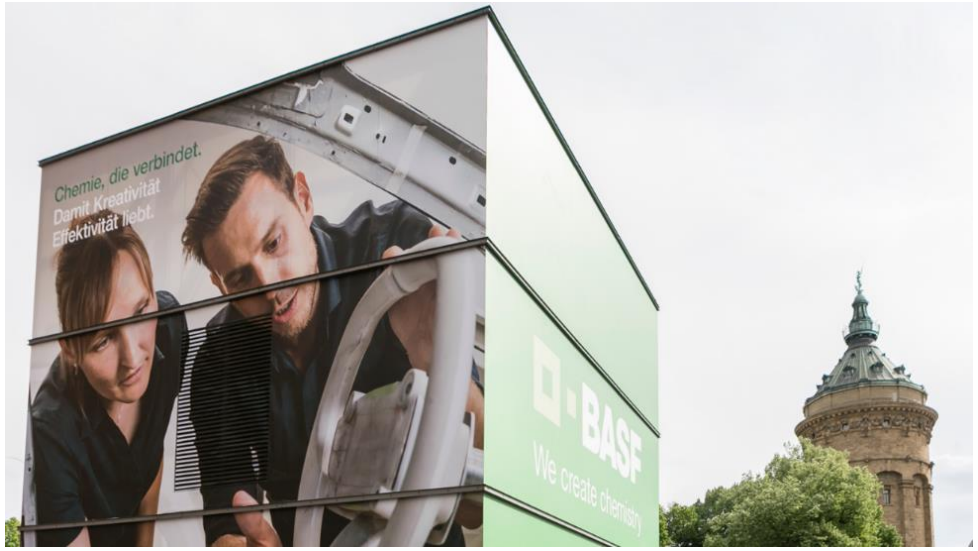
Meeting High Polymer Specifications at a Lower Cost with B2Last®

Presented by:
Brian Orr, B2Last Senior Asphalt Technologist
Bernie Malonson, B2Last Marketing Manager

Agenda

- Housekeeping
- Introduction of Panelists
- EHS Overview
- B2Last Overview
- Studies and Trials Completed
- Future Research and Trials
- Operational Cost Reductions
- H2S Abatement
- Conclusion
- Q & A



Meet Our Panelists

Brian Orr is the North American Senior Asphalt technologist for B2Last where he leads technical evaluation and commercial implementation.

Prior to joining BASF in 2018, Brian has close to two decades of asphalt industry experience, including positions at Utah DOT, as well as technical leadership roles in asphalt binder laboratory and terminal production and operations management.

Bernie Malonson is the North American Marketing Manager for B2Last supporting industry, DOT and academic engagements. He is currently on four published and pending asphalt-related patent applications.

Prior to joining BASF in 2016, Bernie has held various marketing, business and product development positions with Motorola Inc. and Ford Motor Company.

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B2Last Environmental Health and Safety

B2Last is a safe to use asphalt modifier

- Follows Environmental Protection Agency (EPA) and European Chemicals Agency (ECHA) regulations and provisions.
- Does not require unique personnel protective equipment (PPE).
- Poses less hazards and health risks than other common asphalt modifiers or additives.

B2Last is based on a chemistry that has been commonplace in the construction industry for decades

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North American Asphalt Industry

Infrastructure Spending Challenges in Canada and the United States due to Covid-19 and other reallocations.

Paving companies strive to optimize the **Cost-Effectiveness** of their operations in a low-bid environment.

Safety and Risk Mitigation is paramount to both agencies and business owners in bringing innovations to market.

Top Stories

COVID-19 Will Create Long-Term Impact On State DOT Revenues

editor@aashto.org May 29, 2020 0 COMMENTS

State departments of transportation continue to grapple with significant revenue reductions due to the COVID-19 pandemic – reductions that many expect will be long-term in nature.

[*Above photo by the Georgia Department of Transportation.*]

B2Last is based on proven BASF technology used in construction trade for decades

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Introducing B2Last from BASF…

A **safe-to-handle** liquid reactive modifier that is stable and does not separate.

1. Allows you to cost-effectively meet **standard and high polymer specifications** with Styrene-Butadiene-Styrene SBS at an **affordable** price point.
2. Supports **reduction in total costs** of production.
    1. Simplifies formulations
    2. Faster production time
    3. Supports safety by reducing H2S emissions

B2Last provides a “Swiss-Army Knife” of functional improvements for modified asphalt production

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North American Launch of B2Last® : July 14, 2020

1. In global development (EU & NA) since 2015.
2. Extensive North American binder and mix testing as part of development.
3. Supports M320 and M332 Asphalt Binder Specifications.
4. High compatibility with SBS.
5. Safe to use and handle.

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News Release

BASF introduces B2Last asphalt pavement modifier for pavement construction in North America

- **Asphalt modification without separation**
- **Less roller passes for compaction**

WYANDOTTE, MI, July 14, 2020 – At the Petersen Asphalt Research Conference, BASF will introduce its new B2Last liquid asphalt modifier in North America, which improves paving operations and helps make roads last longer. Unlike conventional modification systems that require blending and separate over time, B2Last reacts with the liquid asphalt components and does not separate from the asphalt binder.

"BASF focuses on improving asphalt functionality within the flexible pavement industry to produce better pavements and help our customers increase their operational efficiency," said Jaime Garza, Vice President, BASF Monomers, North America. "B2Last complements existing sustainable construction offerings in the BASF portfolio."

B2Last supports current and emerging AASHTO specifications

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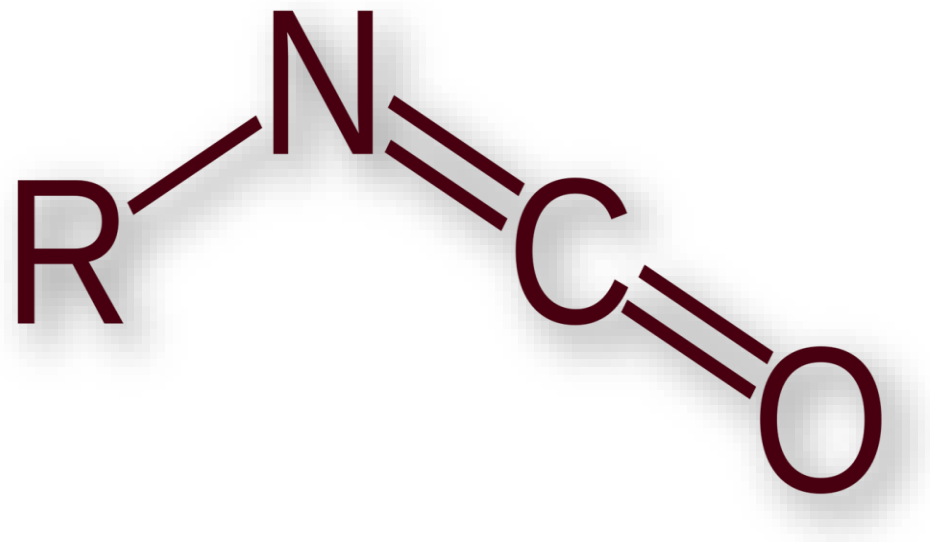
Increasing Use of Reactive Modifiers in Liquid Asphalt

Current Reactive Polymers used as alternative modifiers in asphalt.

- **Reactive Terpolymers**
- **Reactive Copolymers**
- **Selected Epoxies**



The key to B2Last is the reactive N-C-O group which must be treated differently than blends

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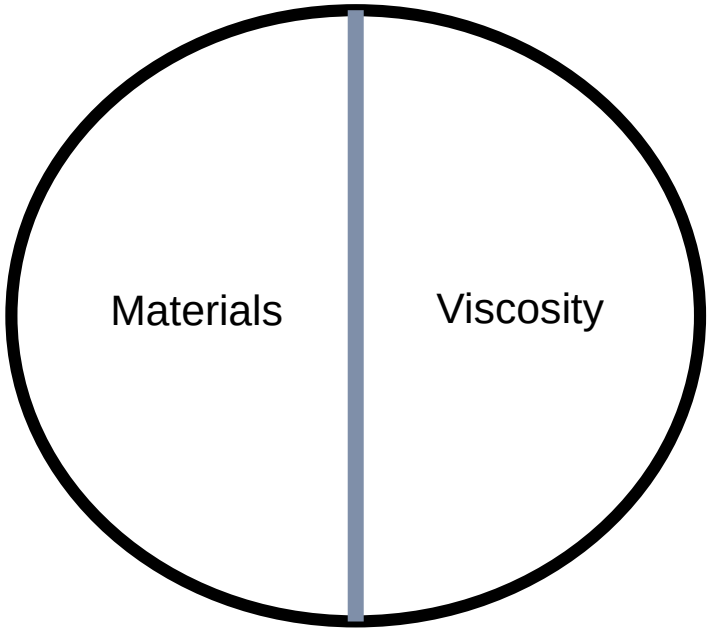
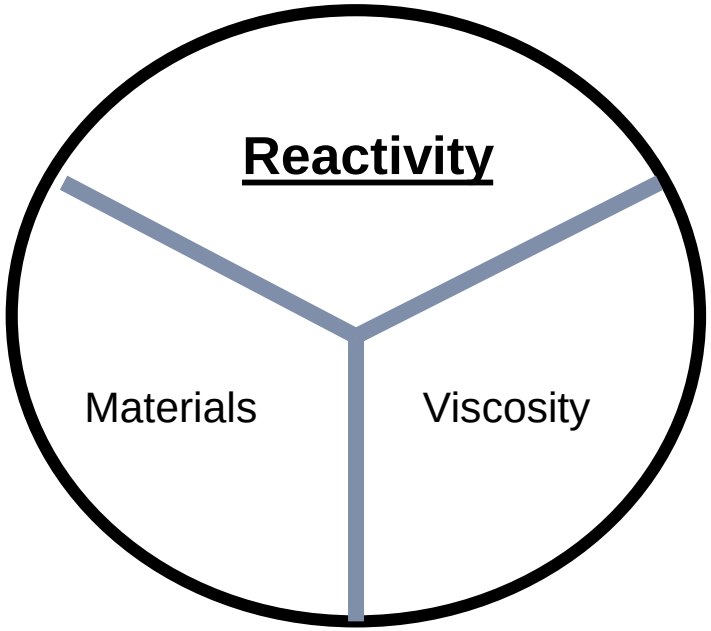
Reactive Modifiers Are Treated Differently Than Blends

Blended Paradigm



Reactive Paradigm



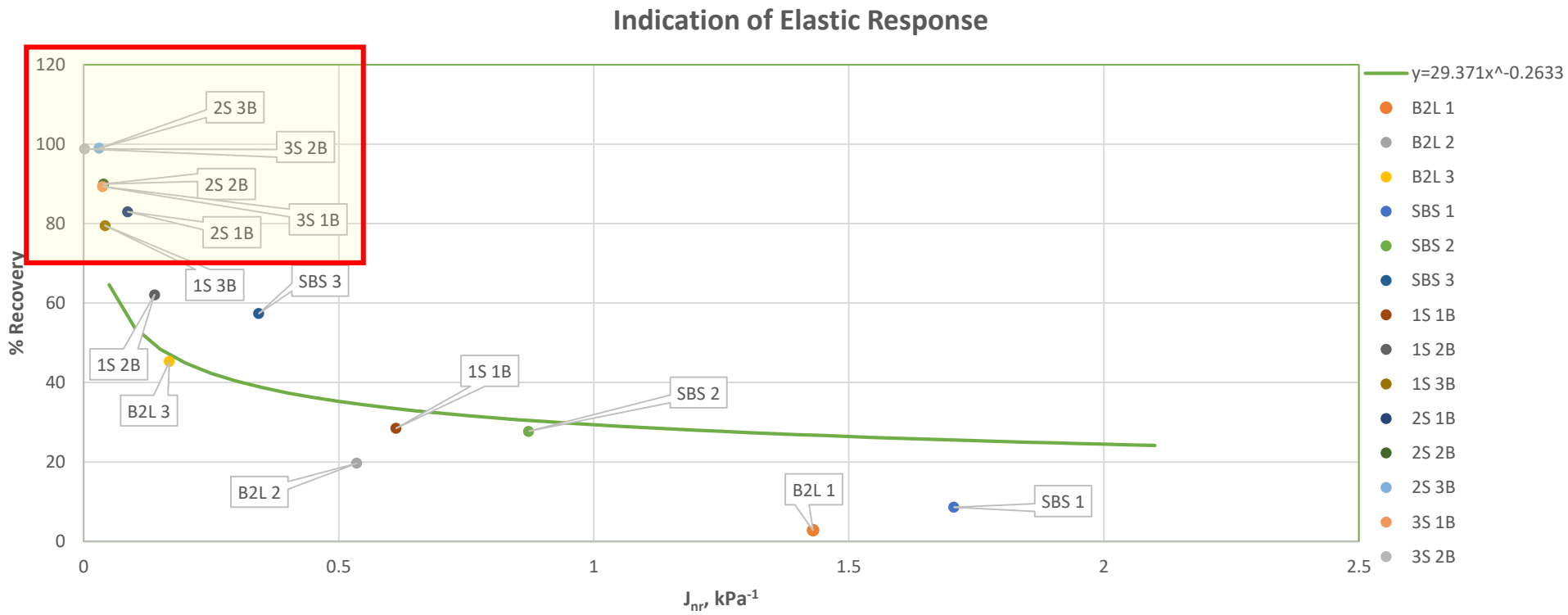
Reactivity of both liquid asphalt and materials, and effect on viscosity must be balanced in formulations

PG 64 – 22 Formulation Study: B2Last (reactive) + SBS (blend) Northeastern / Canadian Asphalt Binder

	Viscosity mPa.S (cP)	SHRP Grading	Temperature Range (°C)
Unmodified	404	64-22	91
1% B2Last	550	70-22	94
2% B2Last	675	70-22	97
3% B2Last	688	76-16	98
1% SBS	583	64-22	94
2% SBS	817	70-22	98
3% SBS	1138	76-22	101
1% SBS 1% B2Last	813	70-22	98
1% SBS 2% B2Last	938	76-22	105
1% SBS 3% B2Last	950	82-22	108
2% SBS 1% B2Last	1209	76-22	104
2% SBS 2% B2Last	1446	82-22	111
2% SBS 3% B2Last	1338	88-22	114
3% SBS 1% B2Last	1917	82-22	109
3% SBS 2% B2Last	2221	88-22	116

Key discovery: SBS + B2Last raised UTI (up to 4+ PG) while keeping viscosity low

AASHTO M332: Multiple Stress Creep Recovery (MSCR) Results Combined B2Last + SBS Formulations



Key discovery: SBS + B2Last modification was able to attain 0 Jnr and 100% Recovery

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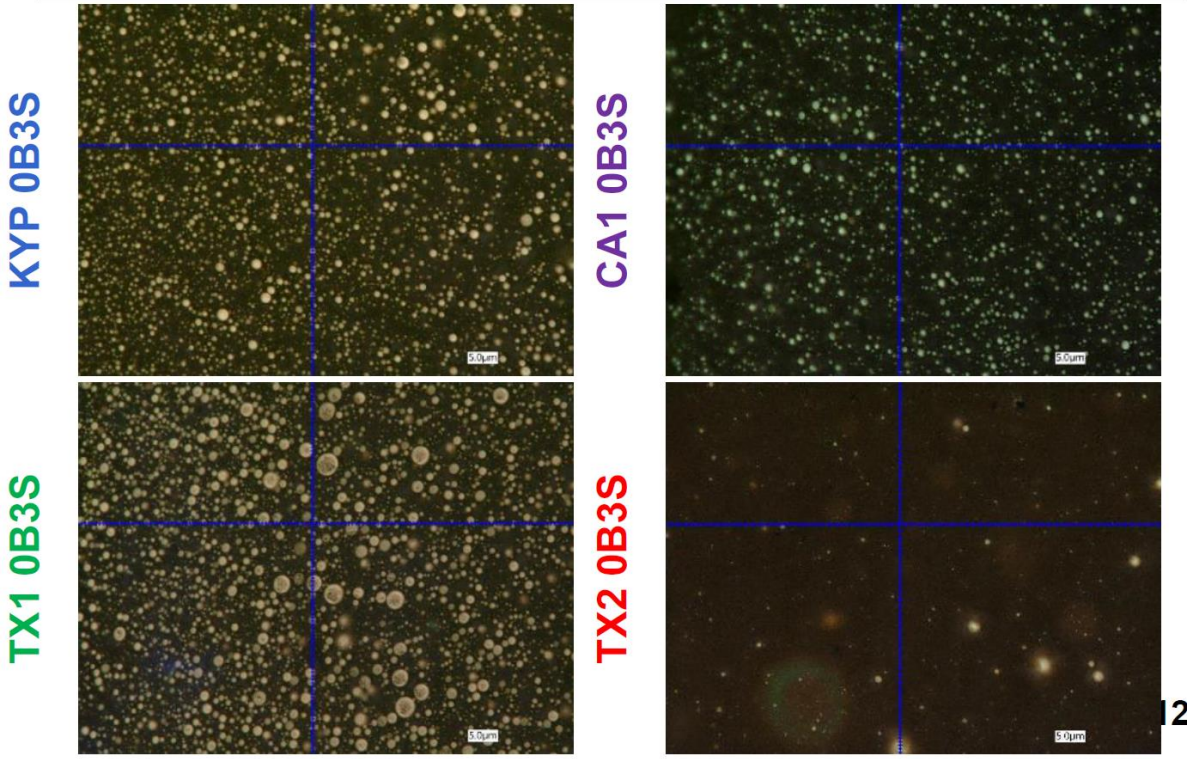
B2Last – A New Paradigm in Asphalt Modification

Current modification paradigm	**B2Last** modification paradigm
ELASTOMER & PLASTOMER	**ADHESIVE**
DRY SOLID	**LIQUID**
INCREASES VISCOSITY	**LOW VISCOSITY**
BLENDED & CAN SEPARATE	**REACTIVE & DOES NOT SEPARATE**
THERMOPLASTIC	**THERMOSET**
ELASTIC RECOVERY LIKE A RUBBER BAND	**ELASTICITY RECOVERY LIKE A RUBBER BALL**

Current testing may not properly characterize B2Last's performance: Stiffness ≠ Cracking

B2Last Reacts and Becomes Part of the Liquid Asphalt Matrix0

WesternResearch INSTITUTE **UV Fluorescence Microscopy Images**



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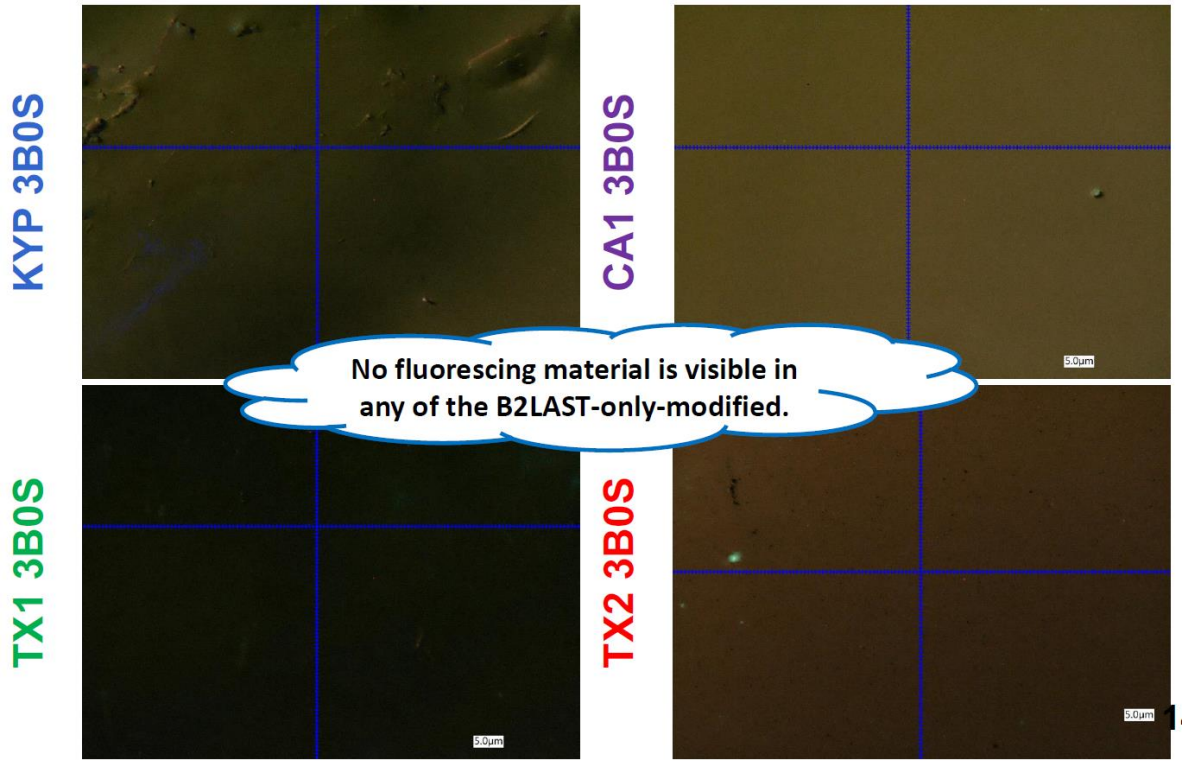

B2Last becomes part of the liquid asphalt matrix and cannot separate

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2020 Petersen Asphalt Research Conference
"High-Polymer" Formulation with Three (3) Asphalts

Research Goals

- Establish initial boundary parameters for technology.
- Challenged to push system beyond "meeting specification".
- Take advantage of knowledge of asphalt binder reactivity.

EXTREME FORMULATION STUDY			
Materials	**MW1**	**South**	**MW2**
Linear SBS	**4%**	**4%**	**4%**
Sulfur	**0.15%**	**0.15%**	**0.15%**
B2Last	**2%**	**2%**	**3%**
Extender Oil (Corn)	**0%**	**0%**	**8%**

Asphalt Binders

- MW1 PG 64 – 22 B2Last + SBS
- South PG 67 – 22 B2Last + SBS
- MW2 PG 64 – 22 B2Last + SBS + Extender Oil

Hold linear SBS constant while varying B2Last and adding extender oil

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B2Last "High Polymer" = Stable Balanced Formulation: 3 Cases

EXTREME FORMULATION STUDY			
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Performance Grade (PG) Specification			
Results	**MW1**	**South**	**MW2**
Continuous Grade	PG 93.7-23.7	PG 98-26.4	PG 89.2-35
UTI	117.4	124.4	124.2
Viscosity; cP	2740	3560	2681
Elastic Recovery	90%	90%	85%
Delta Tc	-6.2	-7.1	-4.8

MSCR			
	MW1	**South**	**MW2**
% Rec 0.1 kPa	93.01	90.52	86.21
% Rec 3.2 kPa	87.69	84.12	79.36
Jnr 0.1 kPa	0.0173	0.0116	0.0222
Jnr 3.2 kPa	0.0321	0.0196	0.0489

Low viscosity and up to five (5) PG grade bump using SBS + B2Last in balanced formulation

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Blankenship Asphalt Tech and Training (BATT)
B2Last Cracking and Rutting Study

Study Design

Control and three (3) experimental samples.

- Control (PG66.5-25.2)
- Control + B2Last (PG73.4-24.6)
- Control + SBS (PG73.8-25.3)
- Control + B2Last + SBS (PG80.7-25.4)

Preliminary Findings

B2Last + SBS provided **superior mix test results**.

- Ideal CT Index & Hamburg Wheel Tracker

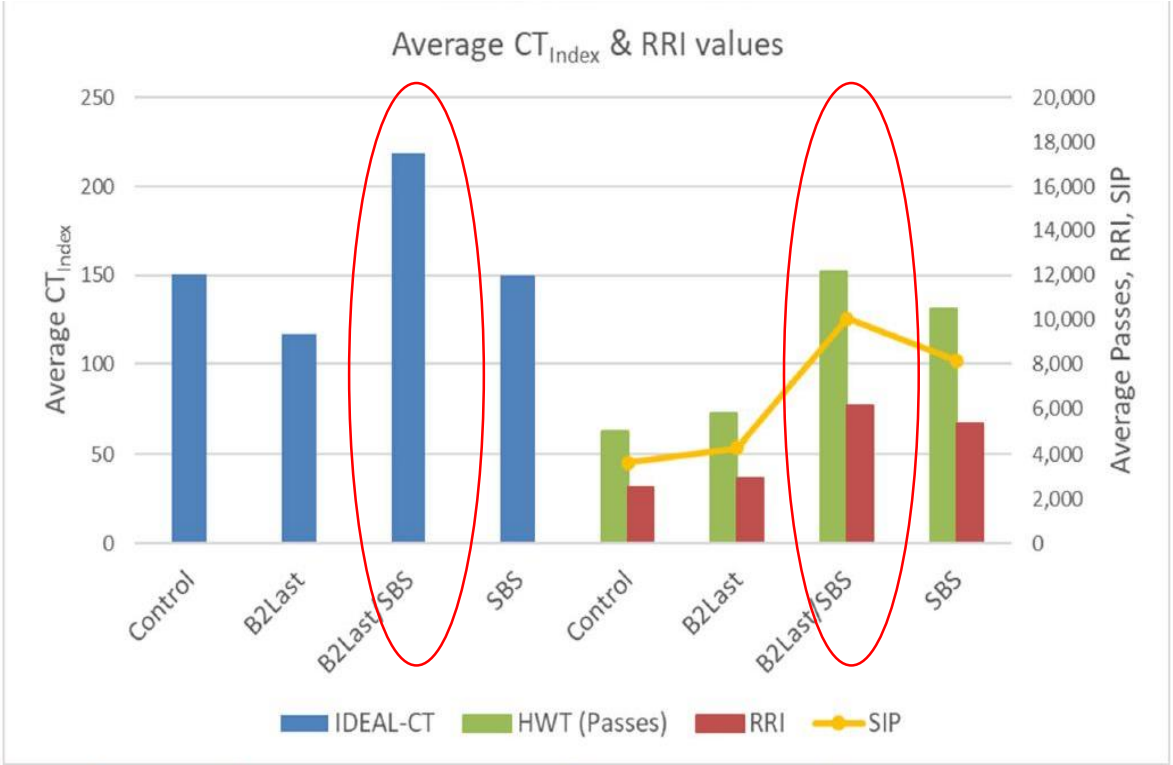

Fig. 1 – IDEAL-CT and HWT test results summarizing CT$_{Index}$, number of passes, Rut-Resistance Index (RRI) and Stripping Inflection Point (SIP).

Balanced binder formulation supports balanced mix designs!

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2019 B2Last Paving Trials in Europe and North America

Jun 2019 – Bavaria
- PWC site at A96
- 230 m, one layer
- First public paving

Sep 2019 – Westphalia
- Regional road
- 100 m, two layers
- 2nd layer paved in Nov

Sep 2019 – Midwest 1
- Four rural roads
- 7 miles, one layer

Oct 2019 – Midwest 2
- Neighborhood road
- ½ mile one layer

Oct 2019 – Munich
- City Autobahn 96, 0.5 km
- Asphalt laydown at 140 °C instead of 170°C
- **Paving emissions reduced by 35-65%**

Anecdotal Feedback

"**Excellent workability** of mix while…, containing **50% reclaimed asphalt**"

"**Released well** from off-loader"

"**Less** asphalt **smell** and **odor**"

"Great **workability** of mix **at only 140 °C**"

Successful paving trials continue to assess environmental and paving conditions

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Phase I National Center for Asphalt Technology (NCAT) May 2020 Offramp Paving Trial

Primary Objective:

- Evaluate field constructability of B2Last modified asphalt mixture.

Formulation:

- Base binder of PG67-22.
- Modified with 2% of B2Last to reach PG76-22.

Current results and next steps:

- Crew saw no noticeable difference from traditional polymer modified mixes when mixing, pumping, transporting, and handling.
- No rutting or cracking observed as of August 2020 with 40,000 ESALs applied to 2-inch mill/inlay using mix containing B2Last.
- Surface data to be collected during all four seasons.

Initial and ongoing test results at NCAT are exceedingly promising

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B2Last Increases Modification and Production Flexibility

1. **Six (6) – Eight (8) hour production time** vs. 24-36 hours for SBS-based and other high polymer formulations.

2. **Flexibility in your operations**, allowing you to get product to customers in short notice.

3. **Decreased production utility costs** and potential to reduce labor costs.

By reducing blending time, B2Last can add flexibility to production and reduce operational costs

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How B2Last can help support asphalt industry participants

Potential operational cost savings of up to…

75% reduction in terminal labor costs (decrease in mixing time).

20% Utilities (decreased mixing and storage temperature, mixing time).

95% reduced chemical usage (H2S scavengers, release agents, anti-strip).

40% reduction in terminal maintenance costs.

Using B2Last in your formulations may result in total operational savings up to 30%*

* Your operation's results may vary

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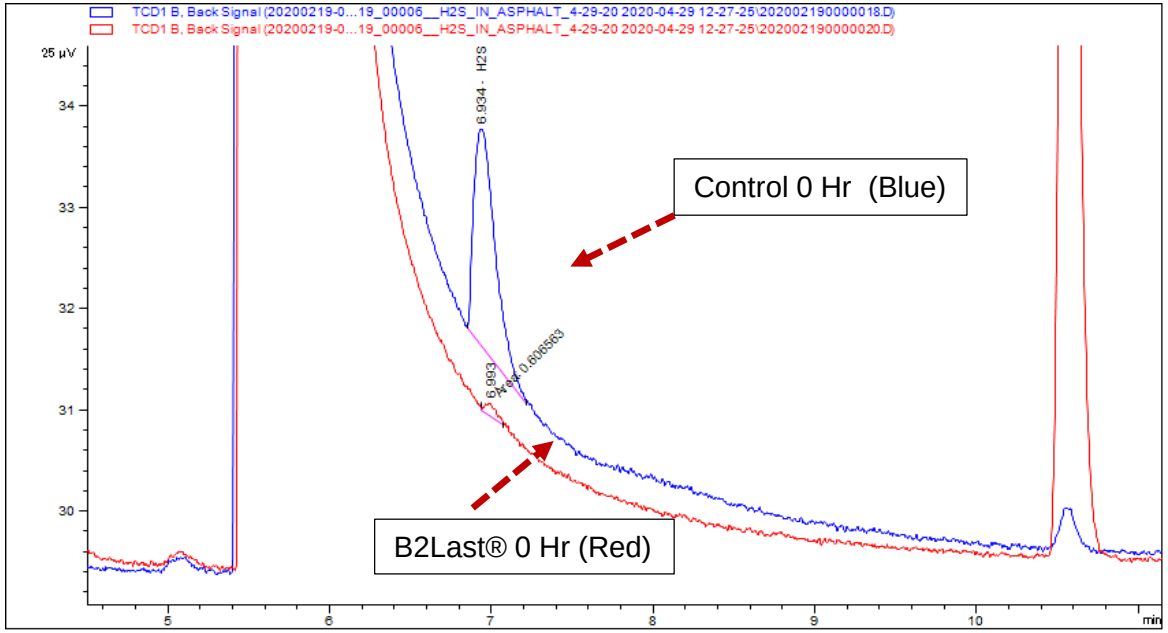
H_2S reduction at asphalt terminal with B2Last

Modified liquid asphalt indicates an **immediate** and **significant reduction** in **H_2S** off-gassing from the addition of **B2Last.**

Further **dosage**, **time**, and **temperature** studies continue to be investigated.



B2Last scavenges sulfur and greatly reduce the release of H_2S

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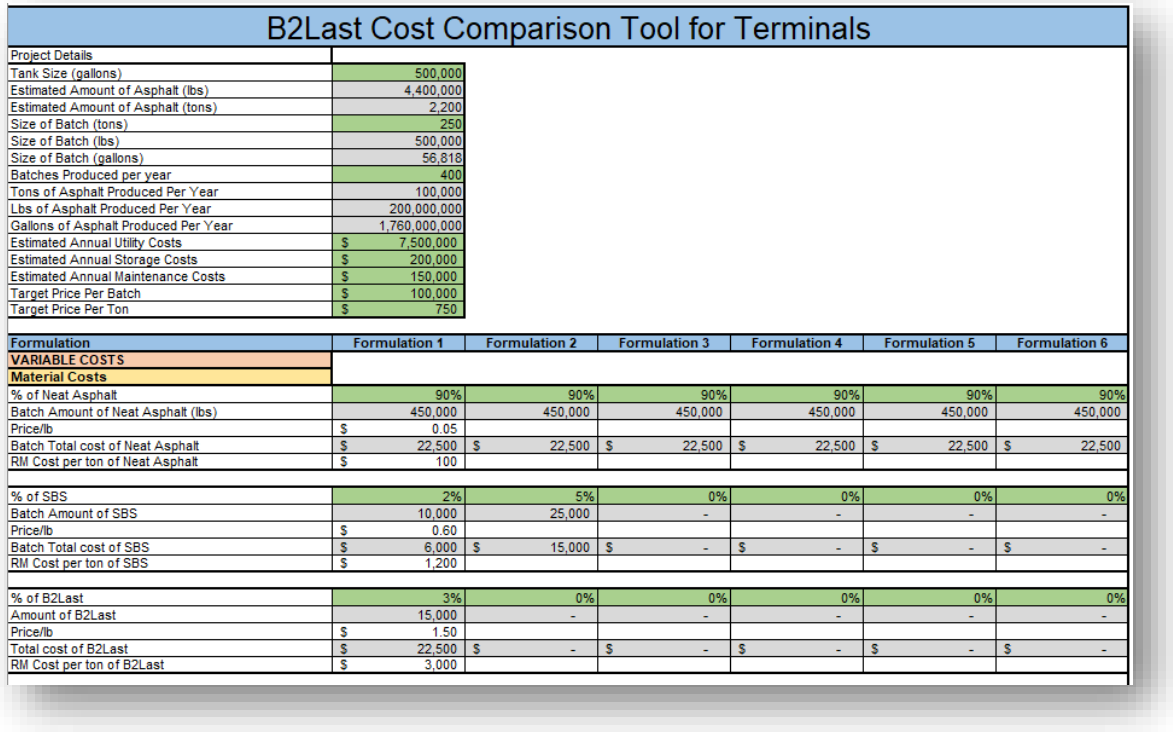
Our team can help you forecast expected savings to your operations using the B2Last Total Cost of Ownership (TCO) Calculator

Calculator estimates the total costs and potential savings associated with different formulations.

- Accounts for material, labor, energy, H_2S scavenger, maintenance, and storage costs.
- Provides an ROI analysis using NPV.
- Demonstrate the economic value of formulating with B2Last to your business.



B2Last Cost Comparison Tool for Terminals						
Project Details						
Tank Size (gallons)	500,000					
Estimated Amount of Asphalt (lbs)	4,400,000					
Estimated Amount of Asphalt (tons)	2,200					
Size of Batch (tons)	250					
Size of Batch (lbs)	500,000					
Size of Batch (gallons)	56,818					
Batches Produced per year	400					
Tons of Asphalt Produced Per Year	100,000					
Lbs of Asphalt Produced Per Year	200,000,000					
Gallons of Asphalt Produced Per Year	1,760,000,000					
Estimated Annual Utility Costs	$ 7,500,000					
Estimated Annual Storage Costs	$ 200,000					
Estimated Annual Maintenance Costs	$ 150,000					
Target Price Per Batch	$ 100,000					
Target Price Per Ton	$ 750					
Formulation	Formulation 1	Formulation 2	Formulation 3	Formulation 4	Formulation 5	Formulation 6
VARIABLE COSTS						
Material Costs						
% of Neat Asphalt	90%	90%	90%	90%	90%	90%
Batch Amount of Neat Asphalt (lbs)	450,000	450,000	450,000	450,000	450,000	450,000
Price/lb	$ 0.05					
Batch Total cost of Neat Asphalt	$ 22,500	$ 22,500	$ 22,500	$ 22,500	$ 22,500	$ 22,500
RM Cost per ton of Neat Asphalt	$ 100					
% of SBS	2%	5%	0%	0%	0%	0%
Batch Amount of SBS	10,000	25,000	-	-	-	-
Price/lb	$ 0.60					
Batch Total cost of SBS	$ 6,000	$ 15,000	$ -	$ -	$ -	$ -
RM Cost per ton of SBS	$ 1,200					
% of B2Last	3%	0%	0%	0%	0%	0%
Amount of B2Last	15,000	-	-	-	-	-
Price/lb	$ 1.50					
Total cost of B2Last	$ 22,500	$ -	$ -	$ -	$ -	$ -
RM Cost per ton of B2Last	$ 3,000					

Contact our team to determine potential 2021 and beyond savings using B2Last

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B2Last Supports Asphalt Industry Specifications & Processes

Departments of Transportation (DOTs)

- Meets / supports AASHTO specifications.
- Backed by both industry and academic research and partnerships.
- Supports sustainability via Life Cycle Cost Assessment (LCCA) and Environmental Product Declaration (EPD).
- Compliant with Environmental Protection Agency (EPA) recommendations.

Asphalt Terminals

- Provides flexibility in production.
- Potentially eliminates the presence of H2S emissions.
- Does not separate when reacting.
- Can be produced in as little as 6 – 8 hours.

Mix Plant / Paving Crew

- No special equipment or handling required; creates a great mix.
- Aids compaction; pavement requires less roller passes.
- Less sulfurous odor and requires less release agent.
- Supports reductions in stripping, rutting and cracking.

B2Last promises to be a game-changing industry innovation for years to come!

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In conclusion, B2Last…

- **Supports AASHTO M320 and M332** specifications
- Allows you to meet **high polymer specifications at a fraction of the cost**
- Can lower terminal operational costs by up to **30%**
- Is **safe to use** when following appropriate handling guidelines
- Nearly **eliminates H2S emission** from asphalt binder
- **Simplifies formulations**
- Reduces mixing time and **adds flexibility to production**

… is NOW available for you to evaluate and implement in your paving projects!

How To Partner With BASF and Get Started Evaluating B2Last

Step 1: Email Us or Visit “Contact Us” on B2LastNA Website

Goal: BASF Asphalt Evaluation

- Provide a liquid asphalt sample to BASF for evaluation.
- BASF will assess binder reactivity and initial formulation.

Step 2: Evaluate B2Last in Your Binder & Mix

Goal: Partner Internal Binder Evaluation

- BASF supplies B2Last EH&S training.
- BASF supplies B2Last sample for your laboratory.

Step 3: BASF Conducts TCO Evaluation and Site Survey

Goal: Establishment of Joint B2Last Operational Targets

- Identify potential savings to your operations with B2Last.
- Identify best methodology to implement B2Last onsite.

Stage 4: Paving / Commercial Trials and Sourcing

Goal: Winter / Spring / Summer / Fall Paving Trials

- Experience for yourself how B2Last improves your operations.

B2Last is commercially available for North American and European trials and sourcing

Brian Orr; Senior Asphalt Technologist

brian.orr@basf.com

“B2Last is an easy, sustainable approach to modifying binders that is readily adaptable to asphalt terminal and tank production operations.”

Bernie Malonson; Marketing & Development

bernie.malonson@basf.com

“Functional performance improvement levels can be tailored or made ‘On-demand’ by binder formulators to meet or exceed flexible pavement specifications.”

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Q & A

Please submit questions to ‘All Panelists’ in the Q & A chat box

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