

HRVATSKO ASFALTERSKO DRUŠTVO



CROATIAN ASPHALT ASSOCIATION

REACTIVE MODIFIER FOR BITUMEN: A NEW WAY TO UPGRADE YOUR ASPHALT MIXES

REAKTIVNI MODIFIKATOR ZA BITÚMEN: NOVI NAČIN ZA POBOLJŠANJE VAŠIH ASFALTNIH MJEŠAVINA

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9. MEĐUNARODNA KONFERENCIJA ASFALTNI KOLNICI 2025 9. INTERNATIONAL CONFERENCE ASPHALT PAVEMENTS 2025

OPATIJA 08. - 09. 05. 2025.

Introduction



Cooling Our Communities – A Guidebook On Tree Planting and Light-Colored Surfacing" U.S. Environmental Protection Agency 22P-2001, January 1992

Actual challenges:

- **1.Increased Temperature**
- **2.Extreme Weather Events**
- **3. Rising Sea Levels**
- 4.Freeze-Thaw Cycles
- 5. Changes in Material Performance
- 6.Maintenance Challenges
- 7.Design Considerations
- **8.Economic Implications**
- 9. Policy and Planning

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The bitumen binder utilized and specified in project tenders are not always suited and designed against heat waves and premature failure of urban road infrastructure in South Europe is more likely to happen.

Introduction Additives to improve asphalt properties*

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Polymer and rubber modifiers

- Thermoplastic Elastomers (i.e. styrenic block copolymers (SBS, SEBS), polyolefin blends, thermoplastic polyurethane)
- Thermoplastics/**Plastomers** (i.e. polypropylene (PP), polyethylene (PE), ethylene vinyl acetate (EVA))
- Elastomers (i.e. natural rubber, synthetic rubber, polybutadiene, butyl rubber)
- Natural Polymers (i.e. lignin/cellulose)
- Crumb Rubber (i.e. reclaimed tyres)
- **Reactive** Elastomeric Ter**polymers** (i.e. glycidyl methacrylate copolymers)

Fillers

- Mineral fillers (i.e. limestone, fly ash and clay)
- Adhesion promoters (i.e. hydrated lime)
- Fibers (i.e. natural cellulose, synthetic polypropylene)
- Natural asphalts (i.e. Trinidad Lake Asphalt, Gilsonite)
- **Recycled asphalt materials** (i.e. recycled asphalt pavement and recycled asphalt shingles)



Chemical modifiers

- · Adhesion promoters (e.g. fatty amine derivatives, imidazolines)
- Surfactants, chemical lubricating additives or waxes for warm mix systems
- Phosphorous compounds (e.g. phosphorous pentoxide, polyphosphoric acid)
- Elemental sulphur
- · Maleic anhydride
- · Odor suppressants, scavengers, and masking agents

*A joint publication of Asphalt Institute & Eurobitume, A Global Perspective: Production, Chemistry, Use, Specification and Occupational Exposure, 2024, 4th edition

& The Shell Bitumen handbook, 6th Edition

Extending and blending agents

- Waxes (e.g. synthetic, such as Fischer Tropsch; natural, such as Montan; and amide derivatives, such as ethylene bis-stearamide)
- Biogenic additives (e.g. vegetable-based components)



Introduction Concept of reactive modifiers





Situmen polar phase bearing reactive groups

Bitumen from Reclaimed Asphalt Pavement (RAP) with more reactive groups (only when reactive modifiers are used at the asphalt mixing plants)

Resulting polymeric network

Introduction A BASF Global Research Initiative for Asphalt

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Co-creation with our global external partner network is essential to link chemistry to road performance

Uses of reactive liquid modifiers in Bitumen & Asphalt

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H2S scavenger

Dosage at 0,5 to 0,8% in bitumen Cost competitive towards actual solution

Additive to shift to higher PG grades

Dosage at 1 to 2% in bitumen Similar cost position

SBS enhance & Elvaloy replacement

Large reduction of SBS at 1% Only cost competitive if the total amount of additives is sufficiently reduced For asphalt mix producer



Anti stripping agent on acidic minerals

Dosage at 0,2 to 0,4% in bitumen Similar cost position

Workability aid and WMA additive

Dosage at 2 to 3% in bitumen Better cost position as it will reduce the overall amount of additives

High performance bitumen binder

Dosage at 2 to 3% in PmB Difficult supply in the market, making this approach more cost competitive (i.e. no long storage at high temperature, ...)

Upgrade of PmB and improvement towards resistance to rutting*





*Rutting tests @70 ° C and 100 000 passes

From lab to field trials – Case Study I

Paving of a bus lane in the city center of Trier (Germany)

■approximately 300t AC 16 BS and AC 8 DS without RAP produced and paved

■Surface and Binder layer based on PmB 25/55-55 with 3,0% of a reactive modifier (AS 101)





Konstantin Platz, Trier, Germany

Parameter		PmB 25/55-55	25/55-55 + 2,5% AS 101	PmB 10/40-65
Softening point	T [° C]	61,8	91,0	72,2
Break temperature	T [° C]	-25,1	-29,3	-28,5
Break strength	[MPa]	3,2	5,2	5,0





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From lab to field trials – Case Study II





Logistic surfaces, Dingolfing, Germany

approximately 1500to AC 16 DS with 50% RAP

- surface layer based on PmB 10/40-65 with 50% RAP modified additionally with 2,5% reactive modifier
- distance from Mixing plant to construction site > 120km
- asphalt mix storage until laydown up to 4-5h after preparation
- laydown temperature at about 160 ° C. Good compactability

Parameters of extracted bitumen		PmB 10/40-65 + 50% RAP	PmB 10/40-65 + 50% RAP+ 2,5% modifier
Softening point	T [° C]	64,4	86,0
BTSV (G* = 15kPa)	T [° C]	59,72	72,4
	δ[°]	71,71	60,9
Elastic Recovery	[%]	50	68



Reactive modifiers in the media & Scientific publications

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Starken Beanspruchungen trotzen

Über die Chancen, die die Multi- hrm. Direktmodifizierung an der Auphaltmischanlage zur Hentellung hochstandfester Oberflächen bietet. sien umwensagen GRADNJA

b2last



UAL HISTAN

Jedan od ova dva uzorka asfalta nema specijalni aditiv za bitumen koji poboljšava izdržljivost puteva

Upotrebom aditiva 82Last putevi se saniraju ređe, a

Multitask additive B2last# for road pavement from BASF

bit 2000, BAH basethed their level new additive for seven was applied, B2Dat R, a new logial modifier in horth Europe and in the USA By chemically modifying the asphelt hindre. BAH developed an innovative instation for the paring malatry. After newly face years of field asage and train is sufficient information. RULed has proven in the an efficient and out effective way is readily behavior.



B2Last, miglierare la chimica del bitume con un nuovo additivo per asfalto a miscela calda

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REACTIVE MODIFIERS TO UPGRADE ASPHALT MIXES



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FOSSIL FUELS | October 25, 2021

Role of Methylene Diphenyl Diisocyanate (MDI) Additives on SBS-Modified Asphalt with Improved Thermal Stability and Mechanical Performance

Josefyn H. Ting, Eesha Khare, Arthory Dellellis, Brian Dir, Jerome S. Jourdan, Francisco J. Martin-Martinez, Kai Jin, Bernie L. Malonson, and Markus J. Buehler*



Chemical modification of bitumen with novel isocyanate-based additive to enhance asphalt performance

September 2021 - <u>Construction and Building Materials</u> 301/1-21/124128 DOI: 10.1016/j.combuildmat.2021124126

Nicolas Carreño - Markus Oeser - Olivier Fleischel

Developing high performance asphalt mixtures with considerable amounts of recycled asphalt with a new chemical bitumen additive

By N. Carrello, M. Geser, M. Zeilinger, O. Fleischel

Book Eleventh International Conference on the Bearing Capacity of Roads. Railways and Airfields



Thermal ageing behaviour of isocyanatebased bitumen additive

Nicolds Hilder Carrielle Glimes * Ä. 🕮, Olivier Falschel *, Markus Deser *

New type of chemical modification of asphalt binders to enhance the performance of flexible pavements

June 2021 Conference: 7 Eurosphalt and Eurobitume Congress

Markus Deser - III Nicolas Cameño - B Remien Lukas - Show al 7 authors - Waldemar Tichatz

Industrial & Engineering Chemistry Research () Vol.48/Issue 18 () Article

ARTICLE | Avgust 11, 2029

Influence of Bitumen Colloidal Nature on the Design of Isocyanate-Based Bituminous Products with Enhanced Rheological Properties

Vegena Carrona[®], Pedro Parta^{1®}, Mondo Earris Mandes[®], Crimpule Saflegon[®], and Artenno Parta[®]

Novel bitumen/isocyanate-based reactive polymer formulations for the paving industry

Mune 48, pages 541-572, (2010) Clin this article

Virginia Carrera, Moises Garcia-Morales 🔁 Pedro Partal & Crispulo Gallegos

Merci pour votre attention!



