Overview of Rejuvenators

Southeastern Asphalt User/Producer Group Annual Meeting
Raleigh, NC
September 15-16, 2022
Grover Allen

Why Should We Consider Rejuvenators?




Avg RAP = >20% (not likely to decrease)

RAP usage commonly linked to premature failures

What Makes us Believe Rejuvenators Work?

Japan's different approach to RAP:

RAP Binder quality: Considered waste/very low quality

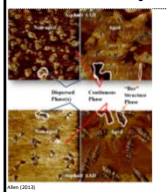
Binder upgrade quality: High quality / Mandatory "rejuvenation"
Method: Pugmill mixing /batching/heating/QC Testing

Avg RAP = 47%
97% roads in Good condition


Conclusions from NCHRP 9-58 – *Evaluating the Effects of Recycling Agents on Asphalt Mixtures with High RAP and RAS Binder Ratios*

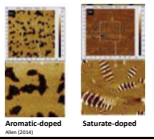
Recycling Agents:
- Reduce stiffness
- Improve fatigue cracking
- Facilitate higher RBR
- Retain rutting resistance
- Retain effectiveness after LTOA

Science of Rejuvenation

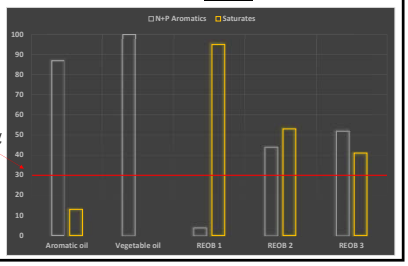


If a rejuvenator is to successfully resurrect an aged facility, it must be able to penetrate the pavement and to a limited depth improve or restore the maltenes-to-asphaltenes balance. **– Boyer (2000)**

Everything shown in the graph is Maltenes

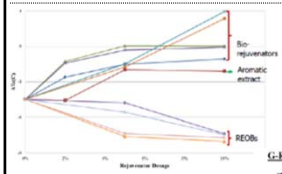


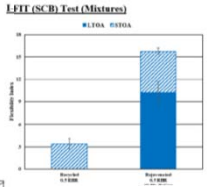
Maximum allowable saturates % to qualify as a "recycling agent" per ASTM D4552 (2020)

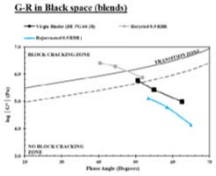


Science of Rejuvenation

Performance of Rejuvenated Materials







- **Industry practice is to follow the producer's recommendation on the dosage (Epps Martin et. Al, 2017).**
- **Standard dosage range:**
- **5-10% rejuvenator / binder on RAP (0.25 – 0.50% / RAP)**

RAP Binder Availability

RAP Binder Availability Factor

Factors Affecting RAP BAF

$RAPBAF = -0.010 \times PGH_{RAP} + 1.771$ for 150°C mixing

NCHRP 09-68 [Active]

Recycled Asphalt Materials: Binder Availability and Its Impact on Mix Performance

Is it Financially Beneficial to Pursue Rejuvenators?

In a world with BMD
(Assume both mixtures below pass BMD performance test criteria)

Scenario 1: (30% RAP): **$33/ton**

Scenario 2: (45% RAP + Rejuvenator): **$30/ton**

In a world where the DOT caps RAP at 30% and enforces a 60% RAP Binder Availability Factor or alternatively allows Rejuvenated RAP

30% RAP: **$38/ton**
(40% of RAP binder wasted)

30% RAP + Rejuvenator: **$35/ton**

Rejuvenating Fog Seal

Asphalt Technology News

Evaluation of Rejuvenating Fog Seals

For more information, contact Raquel Moraes at moraes@auburn.edu

Complex Modulus & Complex Viscosity @ 60 °C

After 4 weeks – S3, Mississippi DOT

Rejuvenating Fog Seal

Application rate:
0.05 – 0.12 gal/sy

Non-Treated

Treated

100% Rejuvenated RAP Cold Mix

Additive being added to the RAP using windrow method

Use of front loader to mix the RAP and the additive

Finished Project

Case Study on Forensic Evaluation of Field Performance of 100% Reclaimed Asphalt Pavement Cold Mix with Rejuvenator in a Low-Volume Road

1	92	Good
2	84	Satisfactory
3	76	Satisfactory
4	80	Satisfactory
5	68	Fair
6	59.5	Fair
7	54	Poor
8	68	Fair
Average	72.7	Satisfactory

22-month update

Summary

- RAP contains low-quality asphalt
- Rejuvenation upgrades the quality of RAP asphalt and pavement surfaces
- RAP binder availability is a concern – the key is softening the RAP binder
- Plant configuration isn't always conducive to utilizing rejuvenator's full potential

Barriers to Acceptance:

- Most agencies place cap on RAP %
- Most agencies do not use rejuvenators
- Most states allow 100% credit for RAP binder
- States that do not allow 100% credit require additional binder

Best chances for success:

- HMA
  - BMD/Higher RAP/Cost savings
  - Successful long-term field trials using higher RAP
  - Sustainability/Environmental tipping point
- Friction-neutral rejuvenating fog seals
- Cold mixtures

Extracted RAP | Aged Asphalt | 1x PAV | Rejuvenated

Recent/Ongoing Rejuvenator Research

- NRRA Innovation Field Evaluation, Phase II
- NRRA Rejuvenating Fog Seal
- NRRA Innovation Project: Use of RA in CIR Emulsions
- NCAT Test Track 2018-2021 Cycle Final Report
- NCAT Study on RA Application Method
- WHRP High RAP/RA Study
- NTPEP RA draft workplan
- NCHRP Rejuvenating Seals
- VTRC RAP/RA field trials (5) and HVS/APT
  - Conclusions
    - May be designed and produced consistently to meet BMD thresholds
    - Equal or better performance is expected for these mixtures (35-60% RAP)

2021 NCAT Pavement Test Track

- Traffic continuation on N3 Anova experiment (3→6 years)
- Traffic continuation of S1 Evoflex section (3→6 years)
- New N8 with Evoflex (base) and EcoBlend (surface) (vs S1)
- Off-ramp rejuvenated cold recycling (RCR) experiment

To preserve and expand the Asphalt Market

Thank you to our AI Members for supporting our efforts.

Questions?

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