The Role of Asphalt Rejuvenators in Pavement Preservation

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Pavement Preservation Is Now On The Mind Of Every Agency Charged With Maintaining Their Inventory Of Asphalt Pavements. The New Reality is there is NO CHOICE but to go forward with a Pavement Preservation Program
The Wheels of Life to the Wheels of Asphalt

In Our Current Economic Climate There Has Not Been A More Opportune Time For Agencies To Consider Rejuvenators. They Have a Long History Of Use...50 Years To Be Exact Use
Price has never been the objection in the use of a rejuvenator. Rejuvenators have a very long history of use – almost 50 years and have been studied extensively from the Corps of Army Engineers, FHWA, US Navy, US States and the National Center for Pavement Preservation.
Yet... Very Few Have A Good Grasp On Product Use And What A Rejuvenator Is
Fog and Rejuvenating Seals in Pavement Preservation

We are talking about processes of utilizing time proven and lower cost preventative maintenance tools to extend the useful life of asphalt pavements to thereby lower annualized resurfacing costs as well as future resurfacing costs.

Are you charting unknown territory?
“If no improvements are made for 1 year, then the number of years remaining until the end of life will decrease by 1 year”

“Assigning Priorities To Fix Worst First Or Reconstruction Is A Proven Death Spiral For Agencies”
The Intended Use Of An Asphalt Rejuvenator Is To Keep Good Roads In Good Condition. When evaluating Pavement Preservation Programs It Is Appropriate To Think In Terms Of Extended Life Rather Than Design Life.

So Why Is It That Asphalt Rejuvenators, A Product Studied More Than Many Other Types Of Treatments, Yet So Unknown By Many In Academia And Those Charged With Maintaining Our Nation’s Pavements Having A Good Understanding Of Rejuvenator Use?

The Mindset today seems to be paint it black, seal the surface.
The Concept of Pavement Preservation With Rejuvenators

It is maximizing performance of assets while minimizing the cost of ownership of that asset.

It is establishing a minimum PCI for your inventory and working to increase that PCI.

It is about extending the RSL or remaining service life of a pavement.
Think of Asphalt Rejuvenators as “Top of the Curve Preservatives”

Rejuvenators are the first step to consider in your pavement preservation program
1. The intent of this chart is to show that prices are going up, not going down. We all know that but don’t want to hear it.

2. Although prices dropped toward year end, this only a blip.
Shifting a small amount of paving dollars to preservation with fog type seals can be very cost effective.
The asphalt rejuvenator Reclamite was introduced by the Golden Bear Oil Company in 1960 out of work beginning in the mid 1950’s by Dr. Fritz Rostler and Richard White.

“Generally failures of asphalt pavements are caused by changes in physical properties during the aging process due to chemical reactions of all or some of the asphalt components”
Asphalt is a black, cementing material that varies widely in consistency...
Asphalts can be separated into two major parts called asphaltenes and maltenes.
Asphalt is a viscous, semi-solid material that takes on the characteristics of its environment as it grows. It is thermoplastic and becomes solid as it cools and melts as it is heated. The asphalt is available in various grades depending on the requirements of the project.

The asphaltene fraction in asphalt is the main color component. They are black or dark brown in color and provide asphalt with a unique appearance. The asphaltene fraction is also responsible for the color and hardness in asphalt.

Composition and Performance of Asphalt
Asphalt cement is composed of various mineral fractions that contribute to its physical properties. The mineral content can be determined through various analytical methods.

The asphaltene fraction in asphalt is the main color component. They are black or dark brown in color and provide asphalt with a unique appearance. The asphaltene fraction is also responsible for the color and hardness in asphalt.

The mineral content in asphalt can be determined through various analytical methods. The mineral content can significantly impact the performance of asphalt in various applications.
The maltene resins are viscous liquids that are composed of asphaltic resins and oils. The maltene's resins provide the stickiness, or adhesive qualities, in asphalt while the oils act as the medium in which the asphaltene and resins are carried.
together they form asphalt cement.
Asphalt is a viscous, semi-solid material that is heated to a consistency used to bind material on surfaces at elevated temperatures. It is thermoplastic and will eventually become rigid after cooling. However, it can soften at elevated temperatures, with asphalt made from a light crude oil being softer than asphalt made from a heavy crude oil.

Asphalt is a mixture of various substances, including asphaltene, which is the insoluble fraction of asphalt, and asphaltenes, which are the organic compounds that give asphalt its color and odor. Other components include resins, hydrocarbons, and non-hydrocarbons.

Asphalt ages, it becomes harder and more brittle and may lose its adhesion or stickiness.
Thus, the secret of ensuring a long service life of asphalt in pavements is to retard the aging process.
The Function of the Asphalt: The asphalt consists of two main fractions: "asphaltenes" which are the hard brittle component, insoluble and not affected by oxidation and the highly reactive sub-fractions: "maltenes". These maltenes are oily and resinous in appearance.

The function of the asphaltenes is to serve as the bodying agent.

“Maltenes” is the collective name for the remainder of the asphalt material left after the precipitation of the asphaltenes. The 4 bodies of matenes are:

- **Polar compounds**
- **First acidiffsins** – resinosous hydrocarbon which act as a solvent
- **Second acidiffsins** – act as a solvent
- **Saturated hydrocarbons** – act as a jelling agent
Components of Rejuvenators

The Maltenes

- First acidaffins
- Second acidaffins
- Saturated hydrocarbons
- Polar compounds
- Asphaltenes
“Keys to a quality rejuvenator”

• Proper base is essential. A naphthenic or wax free base is ideal – the molecular make up offers more solvency or absorption and fluxing ability with the binder.

• Rejuvenators are manufactured as emulsions typically 60-65% residual. They have the ability to “wet” the asphalt binder that is present.
# Asphalt Rejuvenating Agent Specifications

<table>
<thead>
<tr>
<th>Tests on Emulsion</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity @ 25°C, SFS</td>
<td>D-244</td>
<td>15</td>
</tr>
<tr>
<td>Residue, % wt., D-244 (mod)</td>
<td>T-59 (mod)</td>
<td>60</td>
</tr>
<tr>
<td>Miscibility Test(1)</td>
<td>D-244 (mod)</td>
<td>No Coagulation</td>
</tr>
<tr>
<td>Shear Test, 5% w/w</td>
<td>D-244 (Mod)</td>
<td>T-59 (mod)</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>D-244</td>
<td>T-5</td>
</tr>
<tr>
<td>Percent Light Transmittance(2)</td>
<td>GB</td>
<td>GB</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Tests on Residue from Distillation</th>
<th>Test Method</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point, CDC, °C</td>
<td>D-92</td>
<td>T-48</td>
</tr>
<tr>
<td>Viscosity @ 60°C, cSt</td>
<td>D-445</td>
<td>---</td>
</tr>
<tr>
<td>Asphaltene, %</td>
<td>D-2006-78</td>
<td>---</td>
</tr>
<tr>
<td>Melting Distribution Ratio</td>
<td>D-2006-78</td>
<td>---</td>
</tr>
</tbody>
</table>

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ASTM D-244: Determination of Cationic Emulsion. Test for percent of residue is made by heating 50 gram samples to 189 °C (372 °F) until becoming opaque, then cool immediately and calculate results.

CAUTION: Procedure identical with ASME B-244 except that all materials contained in water shall be used in place of distilled water.

Test procedure is identical with ASME B-244 except that distilled water shall be used instead of two percent sulfuric acid solution.

Chemical composition by ASTM Method D-2006-78.

PC = Polar Compounds,

A1 = First Ashaffins,

A2 = Second Ashaffins,

S = Saturated Hydrocarbons.

Note: For gas chromatographic analysis, gas chromatographic analysis may vary from lot to lot.

Note: Data provided is typical. Slight variation may occur from lot to lot.
Typical Changes in the Chemical Composition of Asphalt

- Saturated Hydrocarbons
- 2nd Acidaffins
- 1st Acidaffins
- Nitrogen Bases (Polar Compounds)
- Asphaltenes

Percentages for Original, Aged, and Rejuvenated states.
Reactive components deteriorate causing an imbalance with the asphaltenes.

The loss of the liquid asphalt oils – the maltenes – in the upper 3/8’-1/2” of the asphalt pavement begins the deterioration process.
Effect of Co-Mingling, Densification of the existing A/C Binder (National PP Center Arizona Sealer Binder Study)
SR 95, Winslow, Arizona
St. Louis County, Missouri
Benefits of an Asphalt Rejuvenator:

1. Increases penetration value of the asphalt cement in the top portion of the pavement which extends the pavement’s lifecycle.

2. Seals pavement against intrusion of air and water, thereby slowing oxidation, preventing stripping and raveling and protects the pavement in-depth.

3. Increases the durability of the asphalt in the top portion of the pavement by improving the chemical composition of the asphalt cement.
How Asphalt Rejuvenators are Measured for Their Effectiveness

Reduction in viscosity of the aged asphalt binder is measured to determine the effectiveness.

The viscosity of the recovered binder before and after treatment are determined.

The test methods for the extraction and recovery of the asphalt binder and viscosity measurement require asphalt core slices.
How Asphalt Rejuvenators are Measured for their Effectiveness

4 inch or 6 inch pavement cores are taken and the viscosity of the recovered binder is measured.

Normally the top ½ inch layer of the core is removed for this determination.
How Asphalt Rejuvenators are Evaluated for Their Effectiveness

California DOT (Caltrans) test methods are used:

California Test Method CT 348 – “Method of Test for Determining the Viscosity of Bituminous Materials by Means of the Sliding Plate Microviscometer” (Micro Viscosity)

California Test Method CT 365 – “Method of Test for the Micro-Recovery of Asphalt from Bituminous Core Slices”. (Penetration)
Lab report results of core test data in Texas.

Army Corp of Engineers success levels:
- 45% reduction in viscosity
- 25% increase in penetration

167% increase in penetration

89% reduction in viscosity

88% reduction in viscosity

### Table 1: Microviscosity, 25°C, MP

<table>
<thead>
<tr>
<th>Sample Identification</th>
<th>0.05 sec(^{-1})</th>
<th>0.001 sec(^{-1})</th>
<th>Equivalent Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jason &amp; 10(^{th})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>79.00</td>
<td>89.60</td>
<td>12</td>
</tr>
<tr>
<td>After</td>
<td>9.65</td>
<td>9.80</td>
<td>32</td>
</tr>
<tr>
<td>V Var</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>112.00</td>
<td>115.3</td>
<td>23</td>
</tr>
<tr>
<td>After</td>
<td>9.65</td>
<td>9.80</td>
<td>32</td>
</tr>
</tbody>
</table>
Table 1

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Moisture Loss (%)</th>
<th>Equivalent Priming (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South End Drive</td>
<td>13.7</td>
<td>13.7</td>
</tr>
<tr>
<td>North End Drive</td>
<td>15.5</td>
<td>15.5</td>
</tr>
<tr>
<td>Total Moisture Loss</td>
<td>14.6</td>
<td>14.6</td>
</tr>
</tbody>
</table>

Testing:
The top 3/4-inch of each core was removed for testing. The asphalt was extracted and preserved in accordance with California Test Method 1267-06. The results were determined by the recovered asphalt binder using a dilution plot on a percent bitumen (CPI) 350. The results are reported in Table 1.

Conclusion:
Reported data are based on the testing of selected samples submitted as being representative of the selected and preserved pavements.
City of Cottonwood Heights, Utah
Top 3/8” of Core Samples

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Microviscosity, 25°C, MP 0.05 sec</th>
<th>Microviscosity, 25°C, MP 0.001 sec</th>
<th>Equivalent Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summerhill Drive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Before</strong></td>
<td>41.75</td>
<td>63.33</td>
<td>16</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td>2.71</td>
<td>3.03</td>
<td>53</td>
</tr>
<tr>
<td><strong>Danforth Drive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Before</strong></td>
<td>28.53</td>
<td>39.26</td>
<td>19</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td>7.28</td>
<td>8.21</td>
<td>36</td>
</tr>
</tbody>
</table>
### TABLE I

**CME Construction, Ltd.**

**Data from the City of Indianapolis, Indiana**

<table>
<thead>
<tr>
<th>Core 1 - Top U-Link</th>
<th>STREET</th>
<th>Density</th>
<th>F.I. sec.</th>
<th>Equivalent Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlestown</td>
<td>Before</td>
<td>57.0</td>
<td>182</td>
<td>11</td>
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<tr>
<td></td>
<td>After</td>
<td>62.5</td>
<td>132</td>
<td>15</td>
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</table>

<table>
<thead>
<tr>
<th>Core 2 - Top U-Link</th>
<th>STREET</th>
<th>Density</th>
<th>F.I. sec.</th>
<th>Equivalent Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>College Avenue</td>
<td>Before</td>
<td>65.0</td>
<td>126</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>78.0</td>
<td>98.0</td>
<td>14</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Core 3 - Top U-Link</th>
<th>STREET</th>
<th>Density</th>
<th>F.I. sec.</th>
<th>Equivalent Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>49th Street</td>
<td>Before</td>
<td>34.5</td>
<td>62.0</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>After</td>
<td>6.00</td>
<td>7.40</td>
<td>64</td>
</tr>
</tbody>
</table>
Asphalt Mat Tighter
10 Weeks After Application

Pikes Peak Highway - Photo October 2010
After Reclamite Treatment
Arapahoe County, Co. Easter Road
Before Reclamation Application
Photo - August 2010

Arapahoe County, Co. Easter Road
Photo After Treatment - October 2010
Angola, Indiana
Permeability
Sorptivity
Victoria Harbor,
Georgian Bay
Ontario, Canada
Reclamation Surface Treatment
Scottsdale, Arizona October 2012
Reclamite® Rejuvenating Seal

Scottsdale, AZ Closeup
Rejuvenators can’t correct
"With the Right Care the miles don’t show"

Process of utilizing time proven and lower cost preventative maintenance activities to extend the useful life of asphalt pavements, lowering annualized resurfacing costs and future resurfacing costs.
Which roads make Good rejuvenator candidates?

- Open/Gap Graded HMA
- Aged dense-graded HMA
- Chip seals (loss of rock)
Which roads make BAD rejuvenator candidates?

Dense tight Surface
Not suitable

Dense tight rich surface
Not suitable
Emulsified Asphalt Rejuvenators must be able to penetrate into the asphalt pavement. If not, they should not be used.

Penetration can be determined by the “Ring Test” or by applying by hand sprayer on one squared yard or other test sections at different application rates.

Always evaluate the densest part of the pavement-wheel path.

Asphalt Rejuvenators should only be used on structurally adequate pavements.
Ring Test Kit Appearance
Close up Ring Test Absorption
PRE-CLEANING THE ROAD
Reclamite® Application @ .08 gallons sq. yd, 2:1 with water diluted emulsion
Colorado Applications:

Arapahoe County
Larimer County

City of Lakewood
Greenwood Village
LIGHT COATING OF SAND APPLIED  1 to 2 lbs. sq. yard

Salt Lake City / Sandy, Utah
Sanding Application

Key is maximizing absorption
Midwest Application of Reclamite
Arizona Application
West Coast Rejuvenator Application
City of Lemoore, California - Central Valley
City of Lemoore, California
Penetration of the Rejuvenating Emulsion

City of Lemoore, California
Maximizing Absorption

City of Lemoore, California
FULLY ABSORBED EMULSION

LIGHT COATING OF SAND APPLIED  1 to 2 lbs. sq. yard
SAND SWEPT WITHIN 24 TO 48 HOURS
Travis County, Austin, Texas

Sanded/Swept Appearance 4 days after application
Hyundai-Kia California Proving Ground, Mojave, California

Reclamite® Application
December, 2009
Hyundai-Kia California Proving Ground, Mojave, California

6 year old pavement
.08 gal 2:1 dilute shot rate
750,000 square yards
Life Cycle Extension Calculator

- Current Annual Resurfacing Budget: $2,000,000
- Total L/M Surfaced (8.9 sq yds./ton,$85 ton): 30
- Current Life Cycle Years: 10 years
- Local Cost of Rejuvenator $1.00 sq yd.: $7,040 LM
- Life Extension with Preservation: 5 years
- Current Cost per lane mile: $66,700.00
- New Cost with Reclamite® app.: $73,700.00
- Lane miles/KM that could be exchanged for each lane mile/KM of resurfacing: 9.5 LM
- New Life Cycle with Reclamite® App.: 15 years
- Current Life Cycle Cost per lane mile: $6,700.00
- New Life Cycle Cost with Preservation LM: $4,900.00
- Life Cycle Cost Savings per lane mile: $2,850 per year

- ANNUAL COST SAVINGS: $79,500