The Role of Asphalt Rejuvenators in Pavement Preservation

Jim Brownridge – Marketing Manager - Tricor Refining
Bakersfield, California

Purdue Road School
March 6, 2013
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
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 you 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.
The asphaltene... are... solids when separated... The asphaltenes furnish the color and hardness in asphalt.
PAVING ASPHALT

General Description

Asphalt is a heavy, dark-colored material that varies in consistency from a soft to hard, sticky, or semi-solid. It is thermoplastic and changes its consistency with changes in temperature. Asphalts become softer at higher temperatures. Asphalts consist of a solid phase, through a series of plastic phases in a liquid phase.

Asphalt cement is asphalt that is selected to meet specifications for paving, macadam, and special purposes. It is produced from petroleum crude oil, petroleum fractions, and modified pitch, with the addition of other materials or additives, depending on the requirements of the project. The materials are usually selected to produce an asphalt cement that will meet the required specifications.

The maltenes ... are viscous liquids that are composed of asphalts and oils ... . The maltenes' resins provide the stickiness, or adhesive qualities, in asphalt, while the oils act as the medium in which the asphalts and resins are carried.

Asphalt using asphalt cement is usually part of a macadam or a macadam in which the asphalt is present. The asphalt is usually selected to meet the requirements of the project, and the materials are selected to produce an asphalt cement that will meet the required specifications.

Composition and Performance of Asphalt

Asphalt cement is classified by various factors that are required for various purposes. The asphalt is usually selected to meet the requirements of the project, and the materials are selected to produce an asphalt cement that will meet the required specifications.
Paving Asphalt

General Description

Asphalt is a black, cementing material that is suitable for use as a binder in various types of pavements. It is thermoplastic in nature and becomes soft upon heating. Asphalt is manufactured from a complex mixture of hydrocarbons extracted from crude oil or shale. The asphalt is then processed to remove volatile materials and impurities. The resulting asphalt is a dark, sticky, viscous liquid that is used in the construction of paved roads, sidewalks, and parking lots.

Asphalt binder is a mixture of asphalt, mineral aggregate, and sometimes other materials such as cement or lime. The binder is heated to a temperature where it can be easily poured and spread. The aggregate is then mixed with the binder to form the paving asphalt. The mixture is then compacted and allowed to cool and harden.

The asphalt binder is crucial to the performance of the paved surface. It acts as a sealant, preventing water from penetrating the base materials and causing damage. It also provides a cushioning layer, absorbing and dissipating the energy of the vehicle's tires and reducing noise and vibrations. The asphalt binder also affects the durability of the pavement, with the thicker and more viscous binders providing a longer-lasting surface.

Composition and Performance of Asphalt

The composition of asphalt includes a variety of components, including asphaltene, resin, saturates, and other hydrocarbons. The properties of these components determine the performance of the asphalt binder, such as its viscosity, temperature sensitivity, and resistance to weathering and aging.

The performance of the asphalt binder is also influenced by the type of aggregate used in the mixture. The size and shape of the aggregate particles affect the compaction and stability of the pavement. The asphalt binder must be able to bond with the aggregate particles to provide a strong and durable surface.

Asphalt paving is a cost-effective and durable method for providing access to buildings and facilities. It is widely used in the construction of roads, sidewalks, parking lots, and other paved areas. The use of asphalt paving has become even more prevalent in recent years, with advancements in technology and the development of new and improved materials.
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 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 ACIDIFFINS – RESINOUS HYDROCARBON WHICH ACT AS A SOLVENT
• SECOND ACIDIFFINS – ACT AS A SOLVENT
• SATURATED HYDROCARBONS – ACT AS A JELLING AGENT
COMPONENTS OF ASPHALT AND RECLAMITE

- Asphaltene
- Nitrogen Bases
- First Acid Daffins
- Second Acid Daffins
- Paraffins Saturate
- Reclamite Base Oil
- Reclamite Emulsified Concentrate
Components of Rejuvenators

First acidaffins

Second acidaffins

Saturated hydrocarbons

Polar compounds

The Maltenes

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>Test</th>
<th>Test Method</th>
<th>Test Min.</th>
<th>Test Max.</th>
<th>Requirement</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity @ 25°C, SPS</td>
<td>D-244</td>
<td>T-59</td>
<td>15</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>Residue, % on D-244 (mod) T-59 (mod)</td>
<td>D-244 (mod)</td>
<td>T-59 (mod)</td>
<td>60</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Resistivity Test</td>
<td>D-244</td>
<td>T-59</td>
<td>---</td>
<td>No Coagulation</td>
<td>---</td>
</tr>
<tr>
<td>Scour Test, % on D-244 (mod) T-59 (mod)</td>
<td>D-244 (mod)</td>
<td>T-59 (mod)</td>
<td>---</td>
<td>0.1</td>
<td>---</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>D-244</td>
<td>T-55</td>
<td>Positive</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Percent Light Transmittance</td>
<td>GB</td>
<td>GB</td>
<td>---</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Tests on Residue from Distillation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flash Point, COC, °C</td>
<td>D-92</td>
<td>T-48</td>
<td>196</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Viscosity @ 60°C, cSfT</td>
<td>D-445</td>
<td>---</td>
<td>100</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Alkali Resin %</td>
<td>D-2006-78</td>
<td>---</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Melted Distribution Ratio</td>
<td>D-2006-78</td>
<td>---</td>
<td>0.3</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>PC + A1</td>
<td></td>
<td></td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>S + A2</td>
<td></td>
<td></td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>PC/S Ratio</td>
<td>D-2006-78</td>
<td>---</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Saturated Hydrocarbons, S_{12}</td>
<td>D-2006-78</td>
<td>---</td>
<td>28</td>
<td>28</td>
<td>28</td>
</tr>
</tbody>
</table>

ASTM D-244 Designation Test for percent of residue is made by heating 50 grams sample to 189°C (372°F) until browning occurs, then cool immediately and calculate result.

Test procedure outlined with ASTM D-244 except that 4 liter bismuth nitrate solution be used in place of distillation.

Test procedure outlined with ASTM D-244 except that distilled water be used instead of two percent sodium chloride solution.

Chemical composition by ASTM Method D-2006-78

PC = Polar Components

A1 = First Alkali

A2 = Second Alkali

S = Saturated Hydrocarbons

Note: For further conversion see 242 galons.

Note: Data presented to 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

Percentage distribution over Original, Aged, and Rejuvenated stages.
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

<table>
<thead>
<tr>
<th>Sample Identification</th>
<th>Microviscosity, 25°C, MP</th>
<th>Equivalent Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.05 sec&lt;sup&gt;-1&lt;/sup&gt;</td>
<td>0.001 sec&lt;sup&gt;-1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Jason &amp; 10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>N Viz</td>
<td>79.00</td>
<td>9.65</td>
</tr>
<tr>
<td></td>
<td>89.60</td>
<td>9.80</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>13.5</td>
</tr>
</tbody>
</table>

89% reduction in viscosity

88% reduction in viscosity

167% increase in penetration
CITY OF COTTONWOOD HEIGHTS

Arabah Pavement & Recycling Technologies, Inc.
5950 Grimshole Road
Oceanside, CA 92058
Telephone: 760-320-2194
Fax: 760-320-2094
Email: sales@arabahinc.com

Report: H-1138
Date: December 1, 2008

Customer: Permanent Restoration, Inc. - Rob Wiggins
Project: UTAH (SLC AREA)

Samples submitted: 21 pre-treatment samples of fibers and 4 after treatment identified in follows:
- Support Way
- Castleton Drive
- Fairpark Way
- Utah Road
- Height Drive
- Dynamic Drive

Applications can be treated materials were reported as being UST galvanized pipe perk.

Testing:
The top 36 inch of each core was removed for testing. The uplift was measured and reported in accordance with ASTM D 3069. Variables were determined at the received uplift limits using a dilution plot as provided by ASTM D 3069. All materials were calculated from a composite. The results are reported in Table 1.

Conclusion:
Repaired data are based on the testing of selected samples submitted as being representative of treated and untreated materials.

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Before Treatment</th>
<th>After Treatment</th>
<th>UST Galvanized Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support Way</td>
<td>0.85</td>
<td>0.70</td>
<td>0.80</td>
</tr>
<tr>
<td>Castleton Drive</td>
<td>0.75</td>
<td>0.60</td>
<td>0.70</td>
</tr>
<tr>
<td>Fairpark Way</td>
<td>0.65</td>
<td>0.50</td>
<td>0.60</td>
</tr>
<tr>
<td>Utah Road</td>
<td>0.55</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>Height Drive</td>
<td>0.45</td>
<td>0.30</td>
<td>0.40</td>
</tr>
<tr>
<td>Dynamic Drive</td>
<td>0.35</td>
<td>0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>Total</td>
<td>3.50</td>
<td>2.50</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Table 1
Permanent Restoration
City of Cottonwood Heights, Utah
Date of Commission

For any questions or concerns, please contact Arabah Pavement & Recycling Technologies, Inc. at 760-320-2194.
## 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>Summerhill Drive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>41.75</td>
<td>63.33</td>
<td>16</td>
</tr>
<tr>
<td>After</td>
<td>2.71</td>
<td>3.03</td>
<td>53</td>
</tr>
<tr>
<td>Danforth Drive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>28.53</td>
<td>39.26</td>
<td>19</td>
</tr>
<tr>
<td>After</td>
<td>7.28</td>
<td>8.21</td>
<td>36</td>
</tr>
<tr>
<td>Core #1 - Top U-Link</td>
<td>CHARM-230</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>Before</td>
<td>71.8</td>
<td>103</td>
<td>15</td>
</tr>
<tr>
<td>After</td>
<td>67.0</td>
<td>82.0</td>
<td>14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core #2 - Top U-Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHARM-230</td>
</tr>
<tr>
<td>Before</td>
</tr>
<tr>
<td>69.0</td>
</tr>
<tr>
<td>After</td>
</tr>
<tr>
<td>69.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Core #3 - Top U-Link</th>
<th>CHARM-230</th>
<th>100</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>71.3</td>
<td>81.0</td>
<td>15</td>
</tr>
<tr>
<td>After</td>
<td>64.0</td>
<td>84.0</td>
<td>14</td>
</tr>
</tbody>
</table>
Pikes Peak Highway After Reclamite® Application

Asphalt Mat Tighter
10 Weeks After Application

Pikes Peak Highway- Photo October 2010
After Reclamite Treatment
Angola, Indiana
Permeability
Sorptivity
Victoria Harbor,
Georgian Bay
Ontario, Canada
Reclaimite Surface
Treatment
Scottsdale, Arizona October 2012
Reclamite®
Rejuvenating Seal

Scottsdale, AZ Closeup
Rejuvenators can’t correct
Faulty
Roads !!
“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?

Aged dense-graded HMA

Open/Gap Graded HMA

Chip seals (loss of rock)
Which roads make BAD rejuvenator candidates?

Dense tight Surface
Not suitable

Dense tight rich surface
Not suitable
How to Determine When Asphalt Rejuvenators Can Be Used

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
PINK COLOR DISAPPEARS INDICATING ABSORPTION
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
West Coast Rejuvenator Application
City of Lemoore, California - Central Valley
City of Lemoore, California
Penetration of the Rejuvenating Emulsion

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
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Annual Resurfacing Budget</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>Total L/ M Surfaced (8.9 sq yds./ton,$85 ton)</td>
<td>30</td>
</tr>
<tr>
<td>Current Life Cycle Years</td>
<td>10 years</td>
</tr>
<tr>
<td>Local Cost of Rejuvenator $1.00 sq yd.</td>
<td>$7,040 LM</td>
</tr>
<tr>
<td>Life Extension with Preservation</td>
<td>5 years</td>
</tr>
<tr>
<td>Current Cost per lane mile</td>
<td>$66,700.00</td>
</tr>
<tr>
<td>New Cost with Reclamite® app.</td>
<td>9.5 LM</td>
</tr>
<tr>
<td>Lane miles/KM that could be exchanged for each lane mile/KM of resurfacing</td>
<td>15 years</td>
</tr>
<tr>
<td>New Life Cycle with Reclamite® App.</td>
<td>$6,700.00</td>
</tr>
<tr>
<td>Current Life Cycle cost per lane mile</td>
<td>$4,900.00</td>
</tr>
<tr>
<td>New Life Cycle Cost with Preservation LM</td>
<td>$2,650 per year</td>
</tr>
<tr>
<td>Life Cycle Cost Savings per lane mile</td>
<td>$79,500</td>
</tr>
</tbody>
</table>