

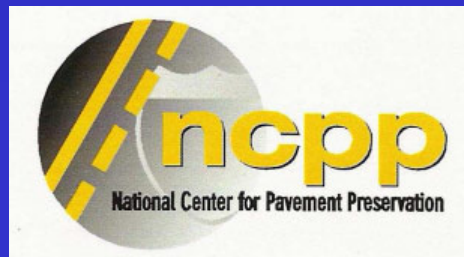
PAVEMENT PRESERVATION WITH

Fog Seal Application of REJUVENATORS & SEAL COATS



John Calvert

Consultant - Pavement Technology, Inc.
Director - Tennessee Public Works Institute



Objective

- Understand the concept of Pavement Preservation;
- Understand asphalt cement components and the aging process of asphalt cement;
- Understand the role fog seal rejuvenators and seal coats can have in a pavement management and preservation program;

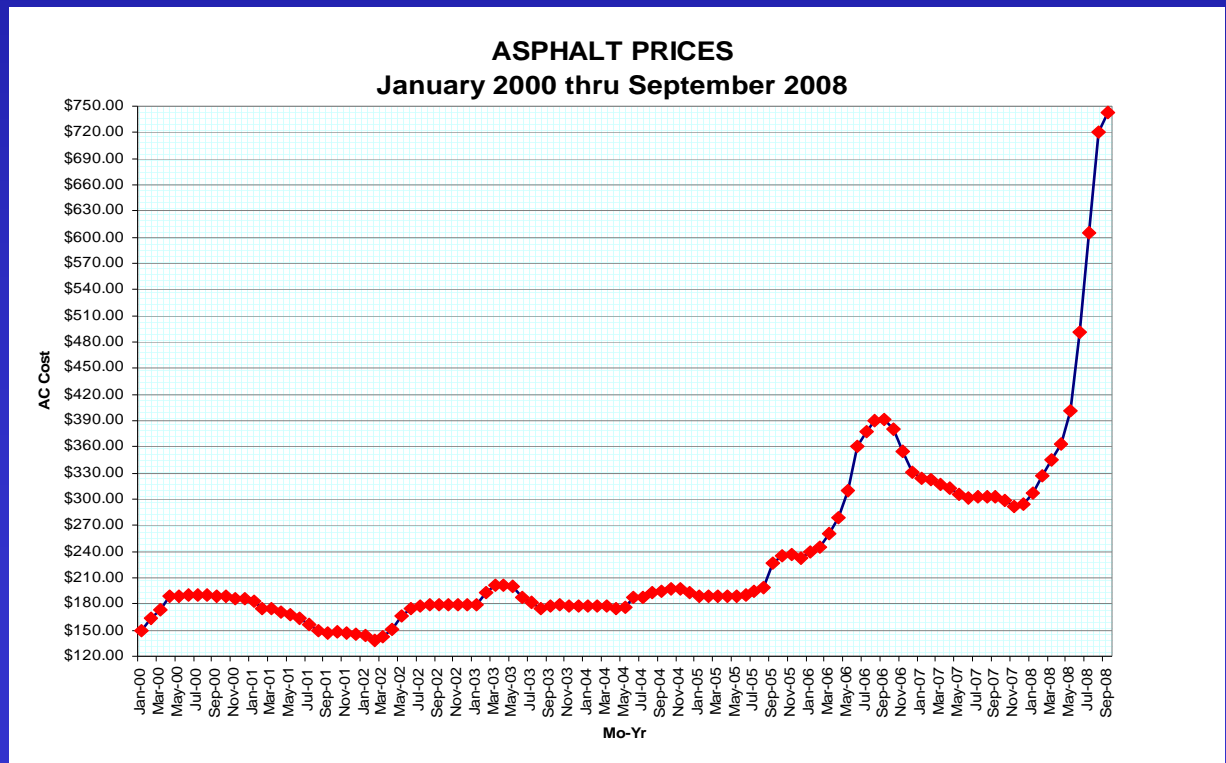
Objective

- Be familiar with various studies and reports performed on pavement rejuvenators and seal coats (sealers);
- Understand the difference between rejuvenators and standard seal coats;
- Understand how to select the proper rejuvenator or seal coat for desired results;
- Understand the proper application process for rejuvenators and seal coats;

Why use fog seal rejuvenators and seal coats?

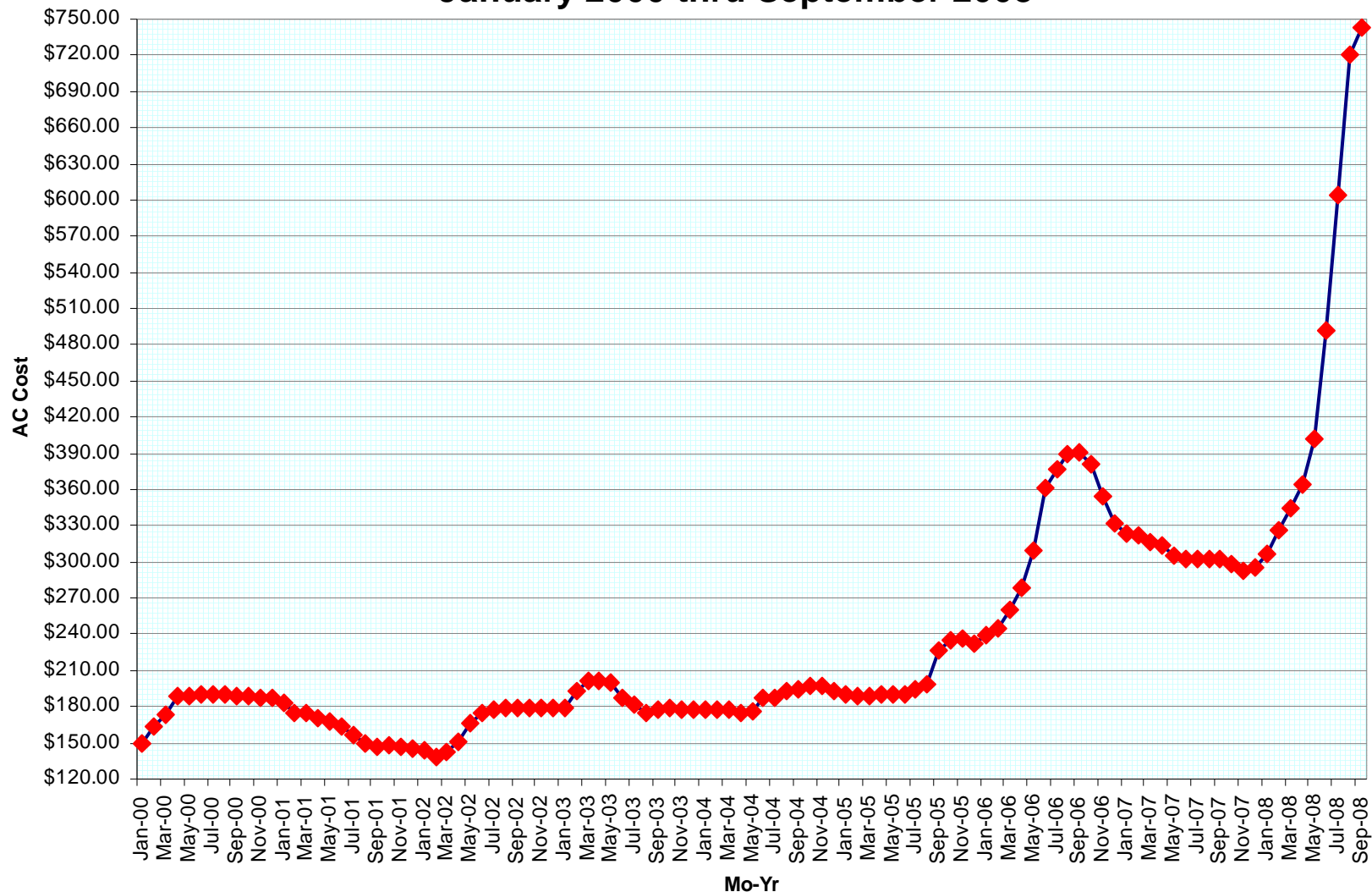
Both are valuable pavement preservation tools that can play a vital part in extending the useful life of asphalt pavements.

This is
important
because of
this.....



The cost of AC has gone from below \$150 to over \$700 per liquid ton from January 2000 through September 2008.

ASPHALT PRICES
January 2000 thru September 2008



This is a major problem for every highway agency that strives to keep its street and roadway pavements in good condition.

This is a major problem because it is making the cost of HMA resurfacing extremely high.

Many agencies simply may not be able to afford to resurface their roadways using conventional methods.

- *Typically AC makes up approximately 6% of hot-mix asphalt.*
- *One SY of 1-1/2" compacted hot-mix, weighs approximately 168 lbs.*
- *6% of 168 lbs = 10 lbs.*

Thus, 10 lbs. of AC per SY of hot-mix



When AC cost was around \$150 per liquid ton the cost for the AC in 1 ton of Hot-Mix was \$9 and the cost of the AC in 1 Lane Mile of roadway (1.5" OL) was \$4,840.

AC Cost Impact on HMA & Paving

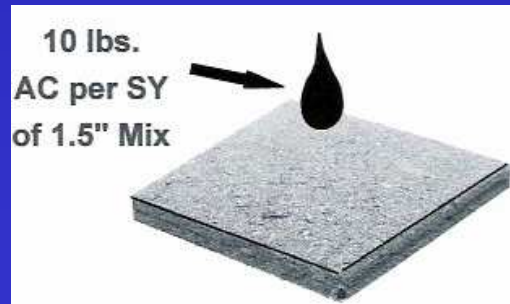
Liq. AC COST ton	AC COST lb.	Lbs. AC in 1 Ton HMA @ 6%	AC Cost in 1 Ton HMA	AC Cost SY 1.5" OL	AC Cost Per Lane Mile (11'w)
\$100	\$0.05	120	\$6.00	\$0.50	\$3,227
\$150	\$0.08	120	\$9.00	\$0.75	\$4,840

Now, at \$700 (LiqTn) the cost for AC in 1 ton of Hot-Mix is \$42 and the cost of it for 1 Lane Mile of roadway is \$22,586.



AC Cost Impact on HMA & Paving					
Liq. AC COST ton	AC COST lb.	Lbs. AC in 1 Ton HMA @ 6%	AC Cost in 1 Ton HMA	AC Cost SY 1.5" OL	AC Cost Per Lane Mile (11'w)
\$100	\$0.05	120	\$6.00	\$0.50	\$3,227
\$150	\$0.08	120	\$9.00	\$0.75	\$4,840
\$200	\$0.10	120	\$12.00	\$1.00	\$6,453
\$250	\$0.13	120	\$15.00	\$1.25	\$8,066
\$300	\$0.15	120	\$18.00	\$1.50	\$9,680
\$350	\$0.18	120	\$21.00	\$1.75	\$11,293
\$400	\$0.20	120	\$24.00	\$2.00	\$12,906
\$450	\$0.23	120	\$27.00	\$2.25	\$14,519
\$500	\$0.25	120	\$30.00	\$2.50	\$16,133
\$550	\$0.28	120	\$33.00	\$2.75	\$17,746
\$600	\$0.30	120	\$36.00	\$3.00	\$19,359
\$650	\$0.33	120	\$39.00	\$3.25	\$20,972
\$700	\$0.35	120	\$42.00	\$3.50	\$22,586
\$750	\$0.38	120	\$45.00	\$3.75	\$24,199

The cost of AC in 1 Sq Yd of overlay (1.5") has gone from \$0.75 to \$3.50.



AC Cost Impact on HMA & Paving

Liq. AC COST ton	AC COST lb.	Lbs. AC in 1 Ton HMA @ 6%	AC Cost in 1 Ton HMA	AC Cost SY 1.5" OL	AC Cost Per Lane Mile (11'w)
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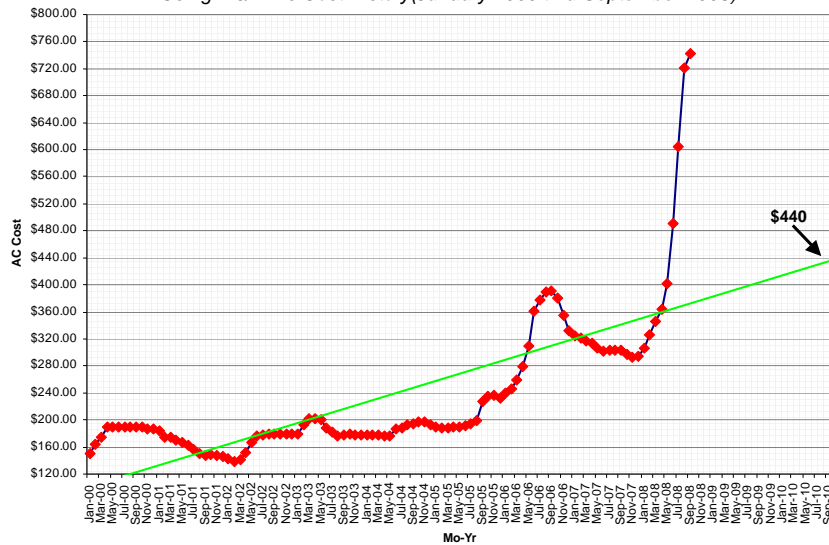
The average cost of HMA In-Place has gone from \$21 per ton to \$97 per ton.

AC Cost Impact on HMA & Paving							
Liq. AC COST ton	AC COST lb.	Lbs. AC in 1 Ton HMA @ 6%	AC Cost in 1 Ton HMA	AC Cost SY 1.5" OL	AC Cost Per Lane Mile (11'w)	HMA COST PER TON IN-PLACE	OL Cost for One Lane Mi.
\$150	\$0.08	120	\$9.00	\$0.75	\$4,840	\$21	\$11,012
\$200	\$0.10	120	\$12.00	\$1.00	\$6,453	\$28	\$14,683
\$250	\$0.13	120	\$15.00	\$1.25	\$8,066	\$35	\$18,354
\$300	\$0.15	120	\$18.00	\$1.50	\$9,680	\$41	\$22,025
\$350	\$0.18	120	\$21.00	\$1.75	\$11,293	\$48	\$25,696
\$400	\$0.20	120	\$24.00	\$2.00	\$12,906	\$55	\$29,366
\$450	\$0.23	120	\$27.00	\$2.25	\$14,519	\$62	\$33,037
\$500	\$0.25	120	\$30.00	\$2.50	\$16,133	\$69	\$36,708
\$550	\$0.28	120	\$33.00	\$2.75	\$17,746	\$76	\$40,379
\$600	\$0.30	120	\$36.00	\$3.00	\$19,359	\$83	\$44,050
\$650	\$0.33	120	\$39.00	\$3.25	\$20,972	\$90	\$47,720
\$700	\$0.35	120	\$42.00	\$3.50	\$22,586	\$97	\$51,391

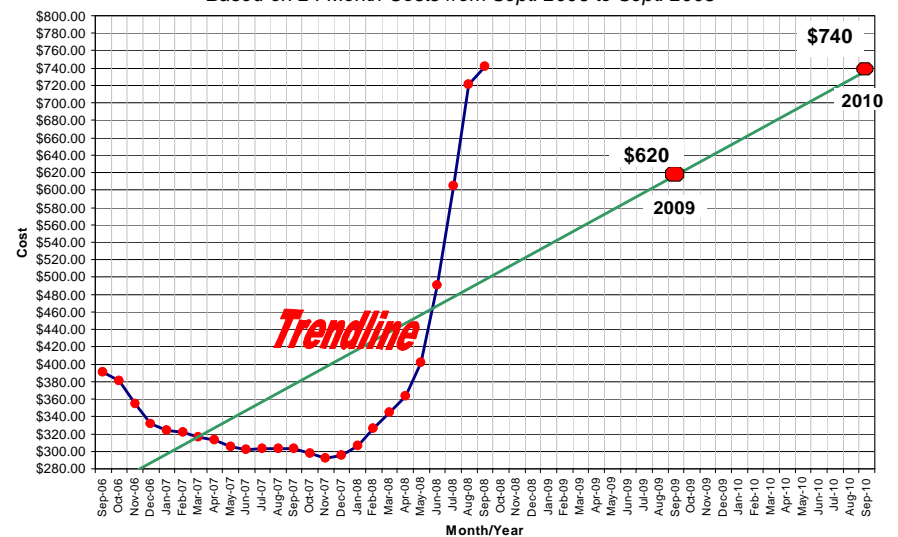
The cost for paving 1 lane mile has gone from \$11K to \$51K.

The future doesn't look much better!

TDOT Bituminous Index - Trendline Projected September 2010
Using 7-3/4 Yrs Cost History(January 2000 thru September 2008)



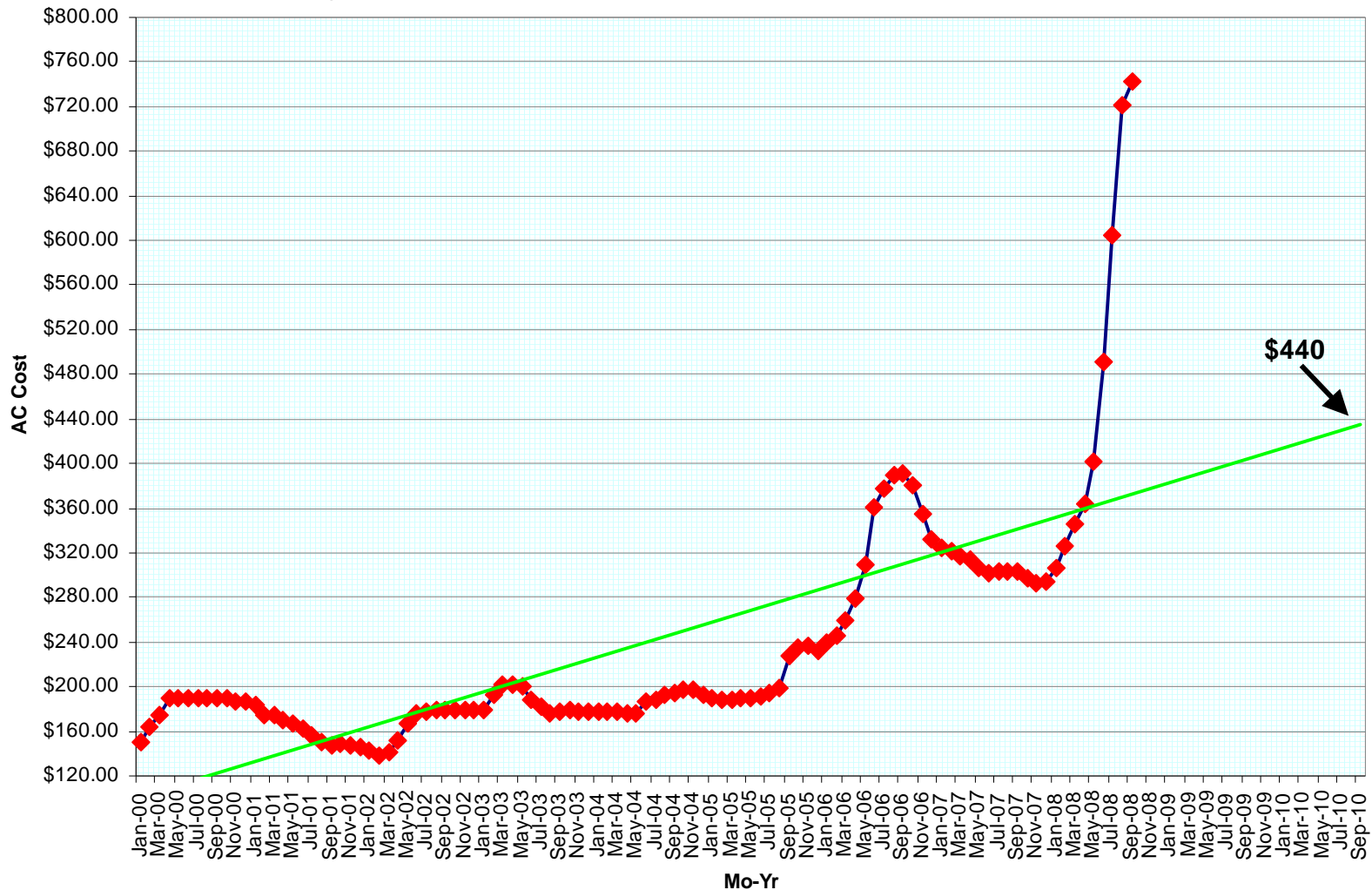
Trendline Projection of Cost for September 2009 and 2010
Based on 24 Month Costs from Sept. 2006 to Sept. 2008



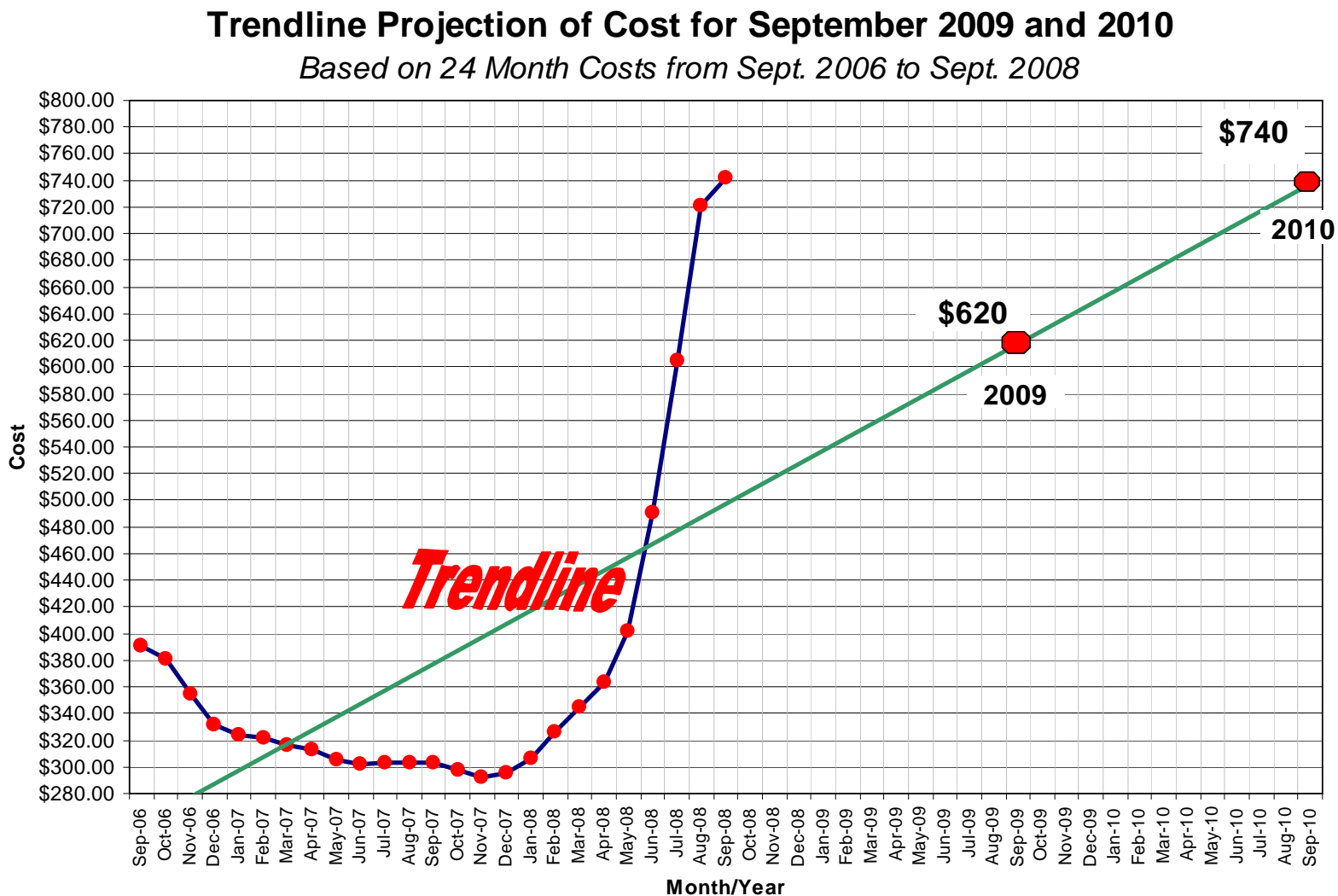
A trendline projection using over 7 years of cost history indicates a possible AC cost of \$440 in September 2010, which is better than what we have now.

TDOT Bituminous Index - Trendline Projected September 2010

Using 7-3/4 Yrs Cost History(January 2000 thru September 2008)

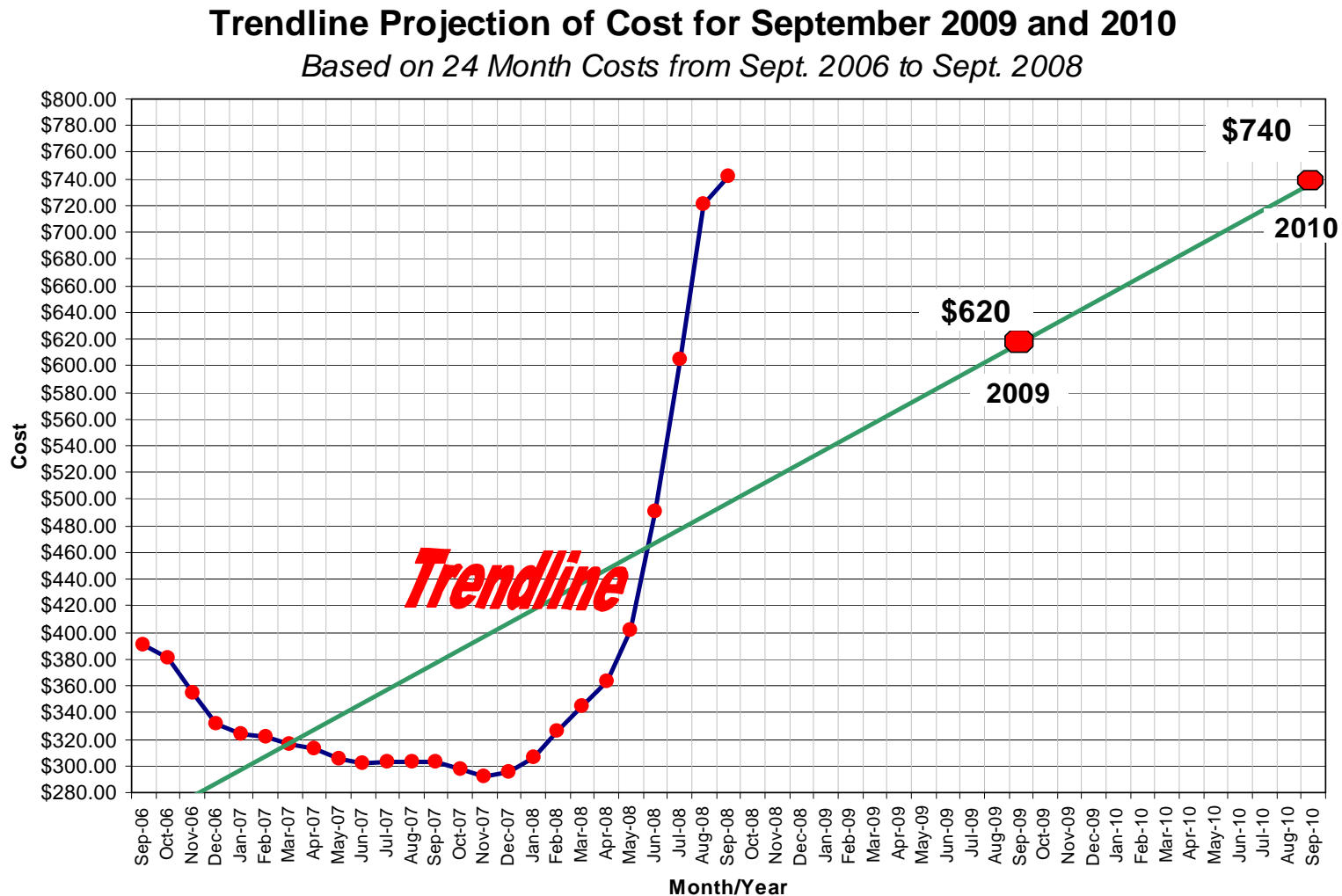


HOWEVER, a trendline projection using the past 24 months cost history projects a cost of \$620 in 2009 and \$740 in 2010.

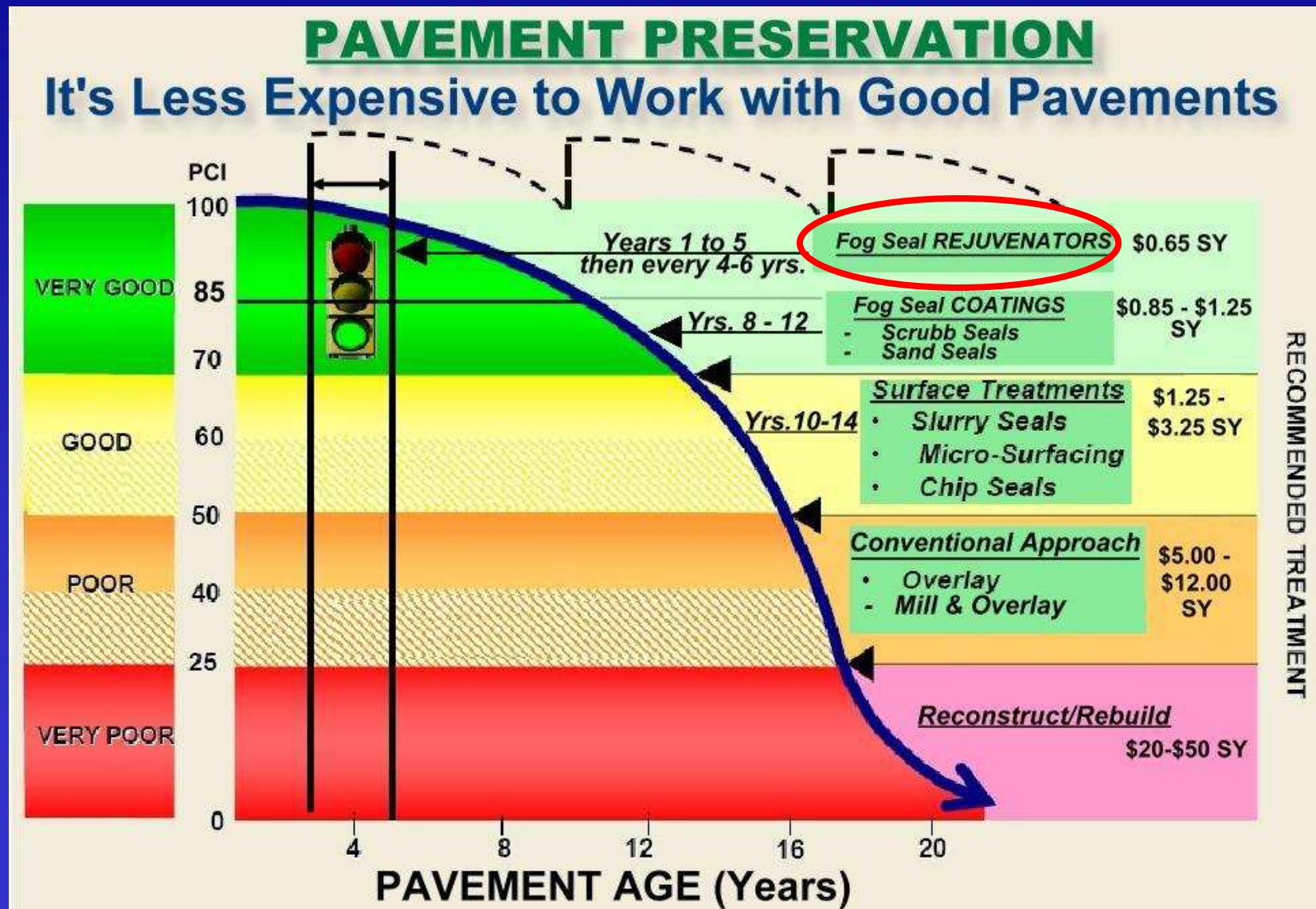


Cost such as these would keep our resurfacing cost around \$40K-\$50K per Lane Mile.

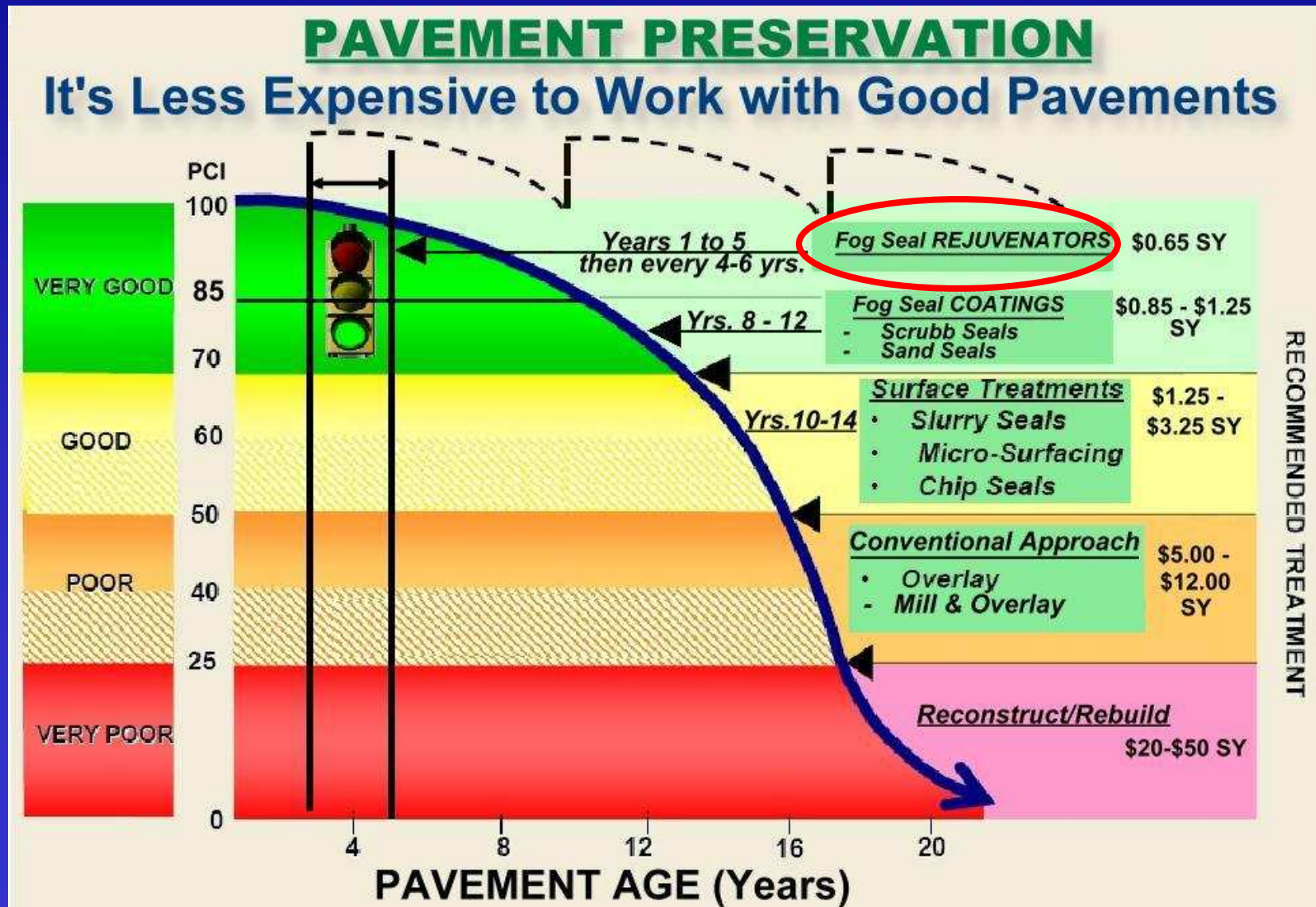
Remember, this is just the HMA cost and not milling, etc.



This is why Pavement Preservation is so important!



The use of Fog Seal Rejuvenators early in a pavement's life then repeated every 4-6 years can greatly extend the life of a pavement.



Numerous studies and reports conducted over the past 30+ years have confirmed the effectiveness of fog seal rejuvenators and seal coats in extending pavement life.

FHWA/FP2 Sealer/Rejuvenator Study

Gayle N. King
Principal Investigator



Report No. FHWA-RD-78-108

TECHNIQUES FOR REHABILITATING PAVEMENTS WITHOUT OVERLAYS – A SYSTEMS ANALYSIS

Vol. 1. Analysis



September 1977
Final Report

Document is available to the public through
the National Technical Information Service,
Springfield, Virginia 22161

Prepared for
FEDERAL HIGHWAY ADMINISTRATION
Offices of Research & Development
Washington, D. C. 20590

Asphalt Rejuvenators “Fact, or Fable”

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Prepared for Presentation at the
Transportation Systems 2000 (TS2K) Workshop
San Antonio, Texas
February 28 – March 3, 2000

PREVENTATIVE MAINTENANCE OF ASPHALT CONCRETE PAVEMENT

By
E. Ray Brown

January 1988

Presented at the 1988 Annual Meeting of the Transportation Research Board



VALUE ENGINEERING

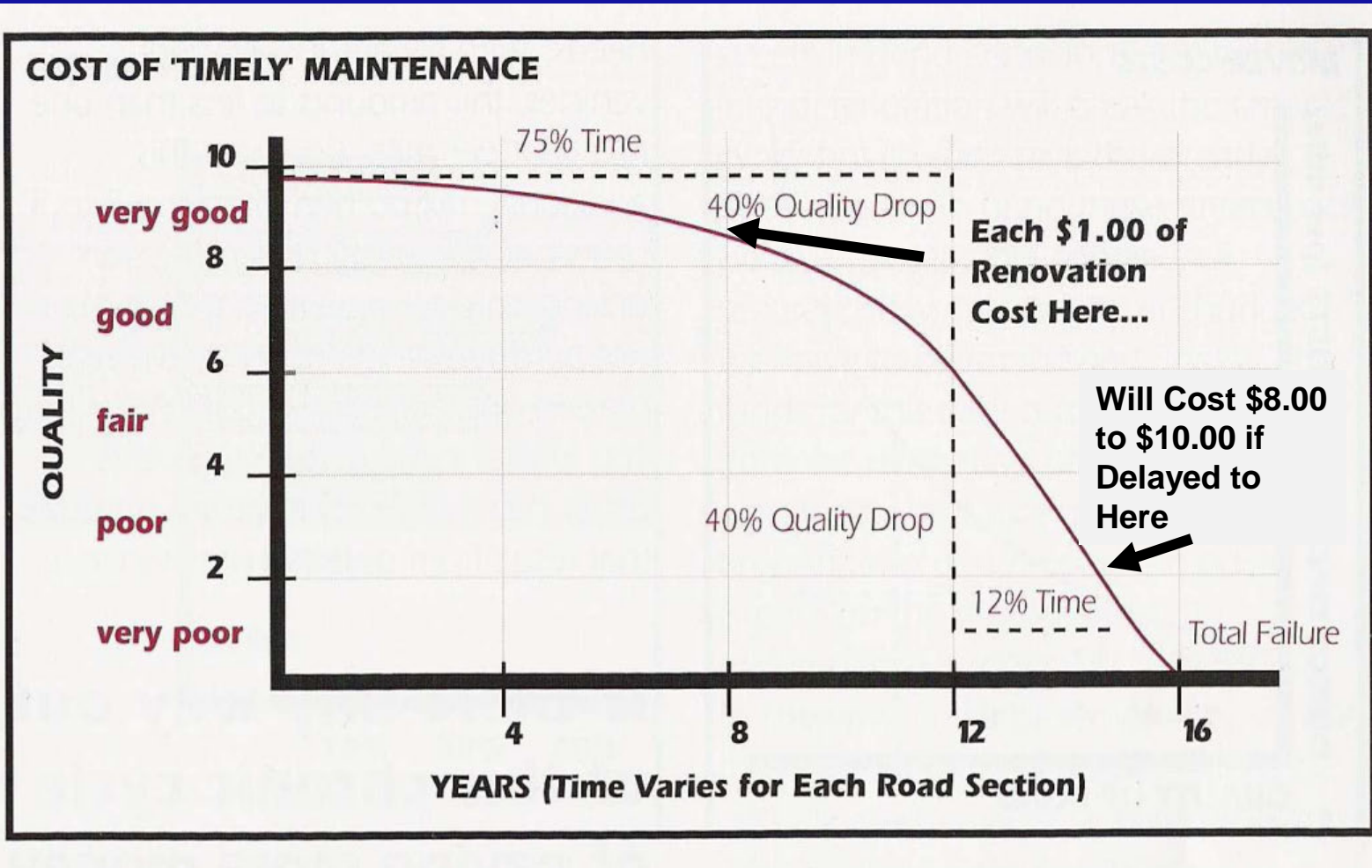
SUBJECT: Report on Reclamite Usage,
Naval Weapons Center
China Lake, Calif.



LOWEST COST
VERSUS
FUNCTION

DEPARTMENT OF THE NAVY
WESTERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
SAN BRUNO, CALIFORNIA 94066

Studies by many D.O.T.s have also shown that every \$1 spent on Pavement Preservation can save \$8-\$10 or more in future maintenance and rehabilitation costs.



Fog seal Rejuvenators and Seal Coats generally cost 10% to 15% of the cost of a conventional HMA overlay.

As such, agencies can generally treat 8 to 10 miles of pavement for the cost of one mile of HMA overlay.

**10 Miles of
Rejuvenator**



FOR

**1 Mile of
HMA Overlay**



Any agency can implement the use of rejuvenators and/or seal coats by simply deferring a small amount of resurfacing.

Miles of HMA Overlay	FOR	Miles of Rejuvenator
5 Miles	→	50 Miles
2 Miles	→	20 Miles
1 Miles	→	10 Miles
1/2 Mile	→	5 Miles



TERMINOLOGY CLARIFICATION



Aren't they all
the same ?

- **What is a Fog Seal?**
- **What is a Rejuvenator?**
- **What is a Seal Coat?**

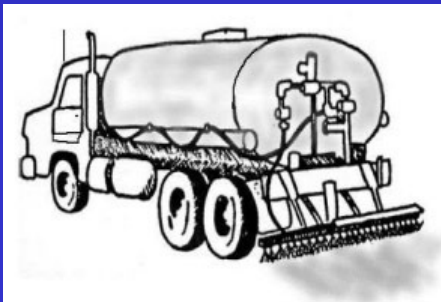
FOG SEAL

There is a lot of confusion regarding the definition of a “fog Seal”.

Some agencies refer to it as a spray application of diluted asphalt cement.

Others refer to it as a spray application of a surface treatment.

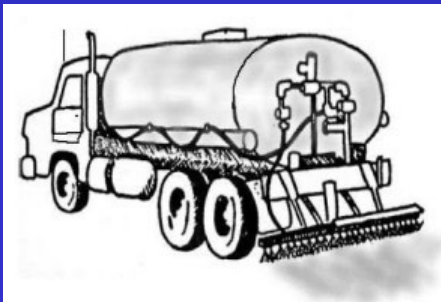
It gets more confusing as some agencies refer to a “Chip Seal” as a *surface treatment*.



FOG SEAL

AEMA's definition is:

"A light spray application of dilute asphalt emulsion used primarily to seal existing asphalt surfaces to reduce raveling and enrich dry and weathered surfaces. It can also be used as a color coating and as a paint striping surface preparation."

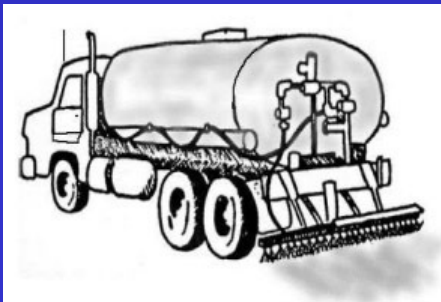


This really doesn't provide much clarification either.

FOG SEAL

To simplify things, it may be best to define fog seal as:

“the spray application of a liquid agent for rejuvenating and/or sealing a pavement surface.”



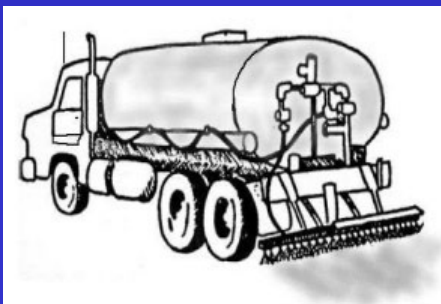
FOG SEAL

This makes sense because both rejuvenators and seal coats are fog seal applications as they are both spray applied.

However, they can differ greatly in chemical makeup.

All fog seals are not the same!

Different fog seals provide different results.



What is a fog seal applied REJUVENATOR?

There is also confusion regarding products referred to as “rejuvenators” and what is and what is not a real rejuvenator.

An asphalt rejuvenator is a maltene base petroleum product which has the ability to absorb or penetrate into an asphaltic concrete pavement and restore those reactive components (*maltenes*) that have been lost from the asphalt cement binder due to the natural occurring oxidation process.

What is a fog seal applied SEAL COAT?

Seal Coats or Sealers are composed of a thin layer of an asphalt material such as cutbacks, asphalt emulsions, or paving grade asphalt cement.

Modifiers are often added to the asphaltic liquid mixture and may include rubber, latex, and polymers.

A few Seal Coat products also contain a small amount of rejuvenator additive though not in the same quantities found in the standard rejuvenator products.

REJUVENATORS



What is a REJUVENATOR?

What are those “maltenes” ?



What is a REJUVENATOR?

What are “maltenes”?

Maltenes are a fractional component of asphalt cement.

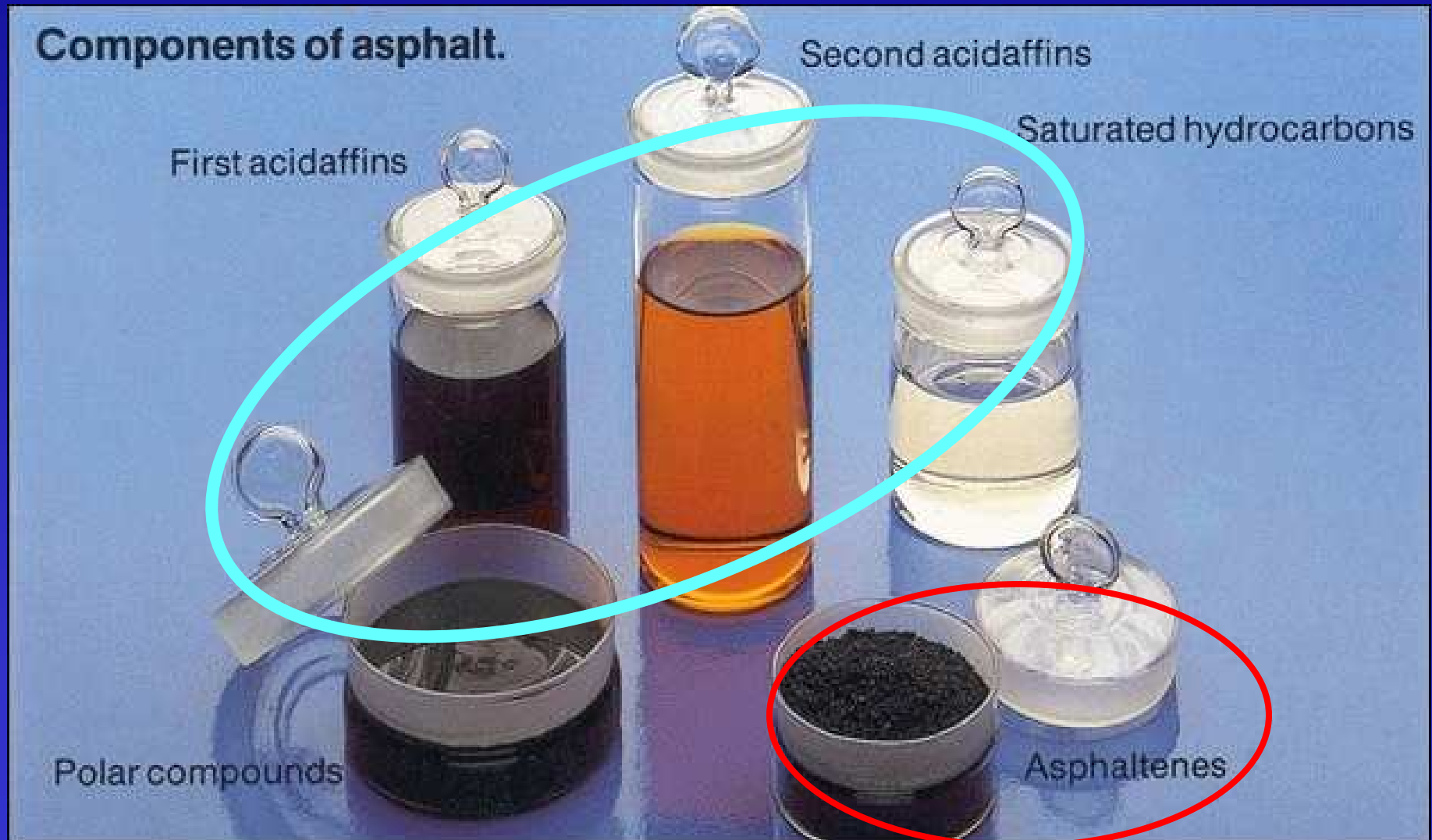


In order to better understand and appreciate how a rejuvenator and seal coat work to extend the life of an asphalt pavement,

.....it's important to remember the general chemical makeup of asphalt cement (AC) and what causes it and asphalt pavements to age and deteriorate.

Petroleum Asphalt is comprised of two fractional components:

ASPHALTENES and MALTENES.



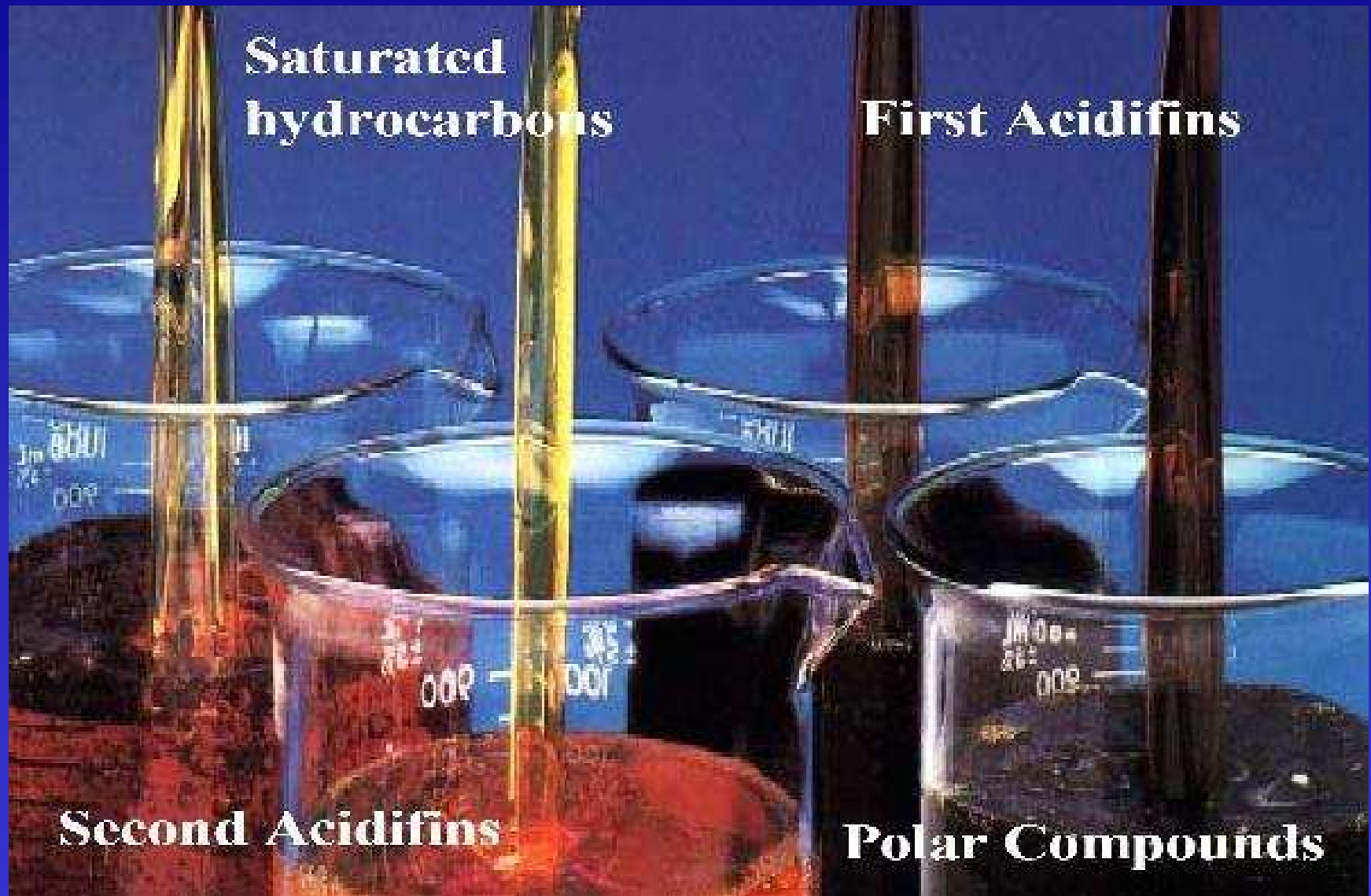
Asphaltenes (A) are defined as that fraction of the asphalt insoluble in n-pentane.

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

Maltenes is the collective name for the remainder of the asphalt material left after precipitation of the asphaltenes.

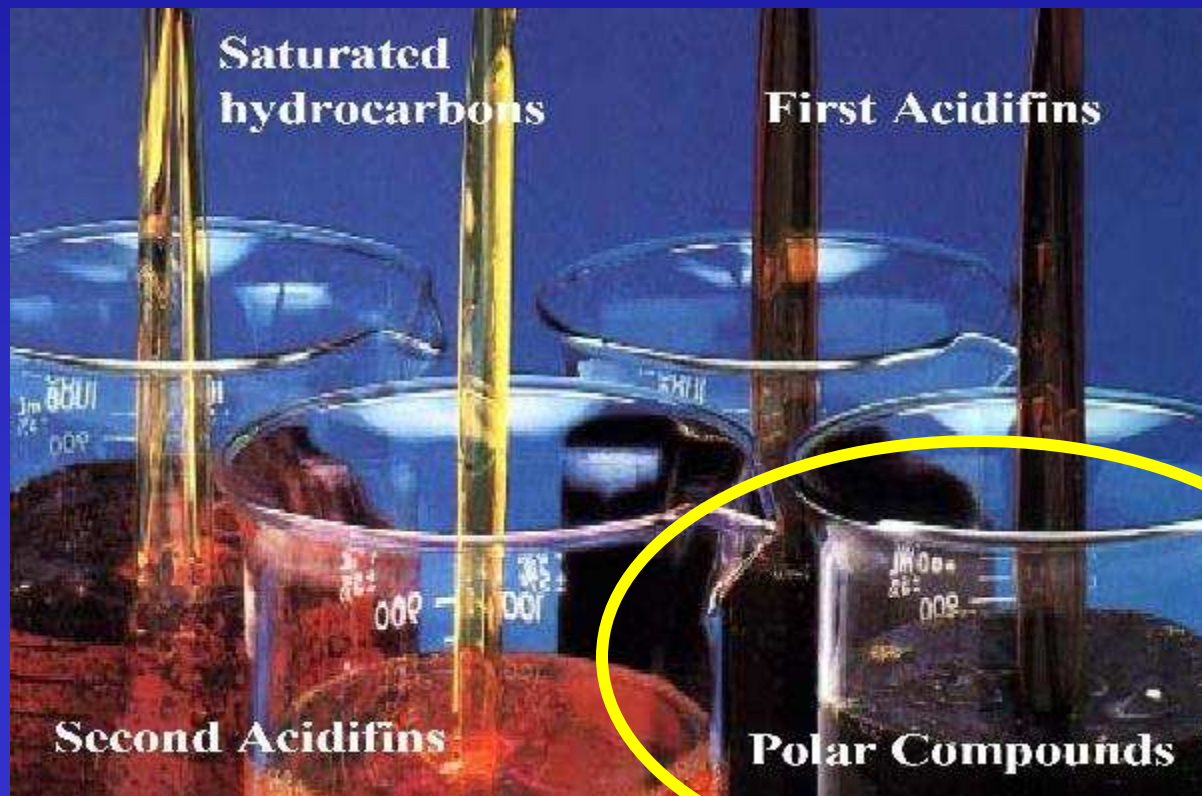
Four principle bodies of maltenes have been identified and each has a specific function.

MALTENE fractions of Asphalt Cement



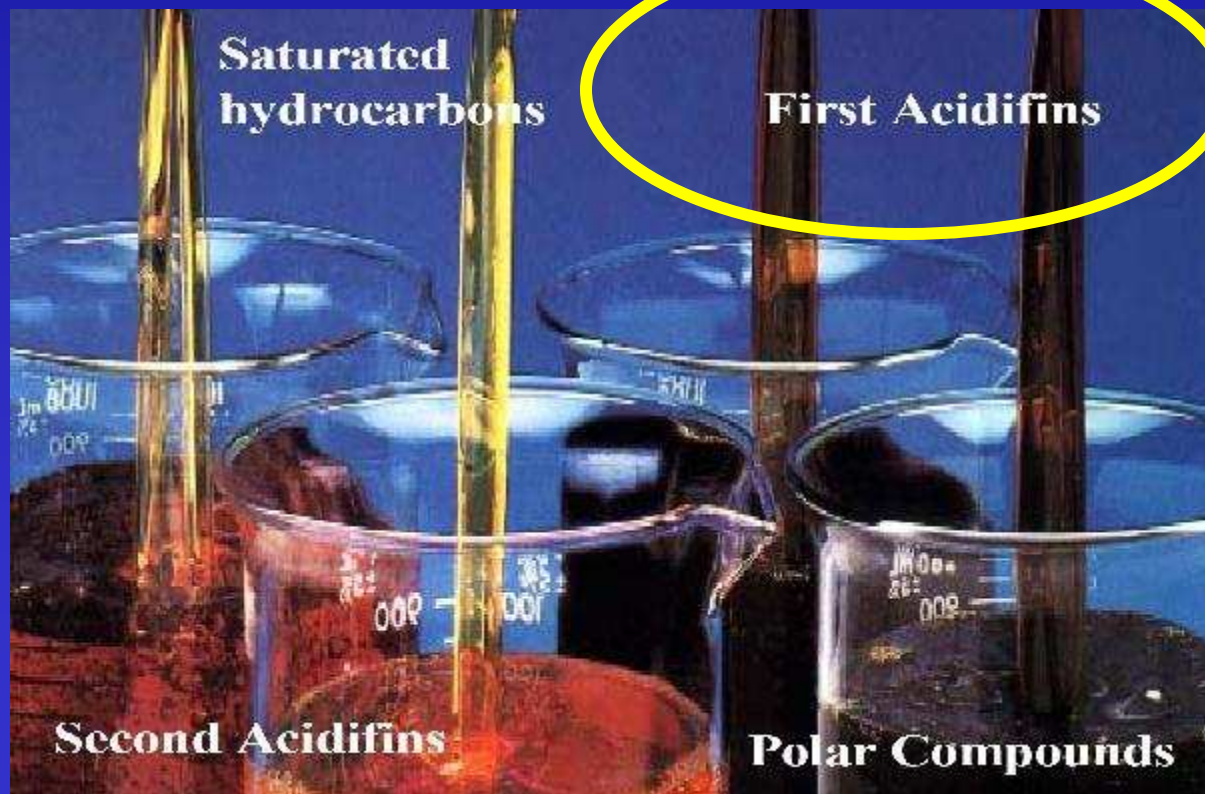
These four bodies are:

1) Polar compounds or Nitrogen bases (N) - components of highly reactive resins, which act as a peptizer for the asphaltenes.



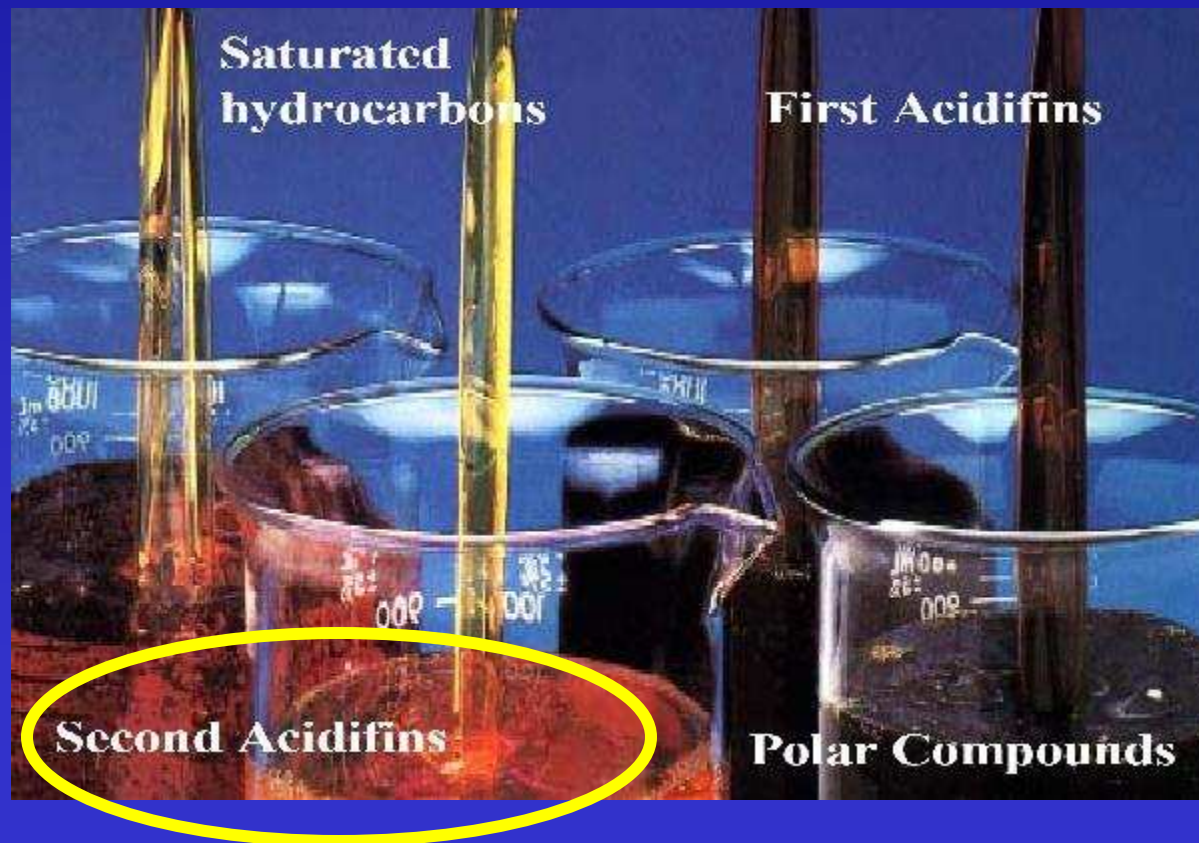
These four bodies are:

2) First acidifins (A1) - components of resinous hydrocarbons which function as a solvent for the peptized asphaltenes.



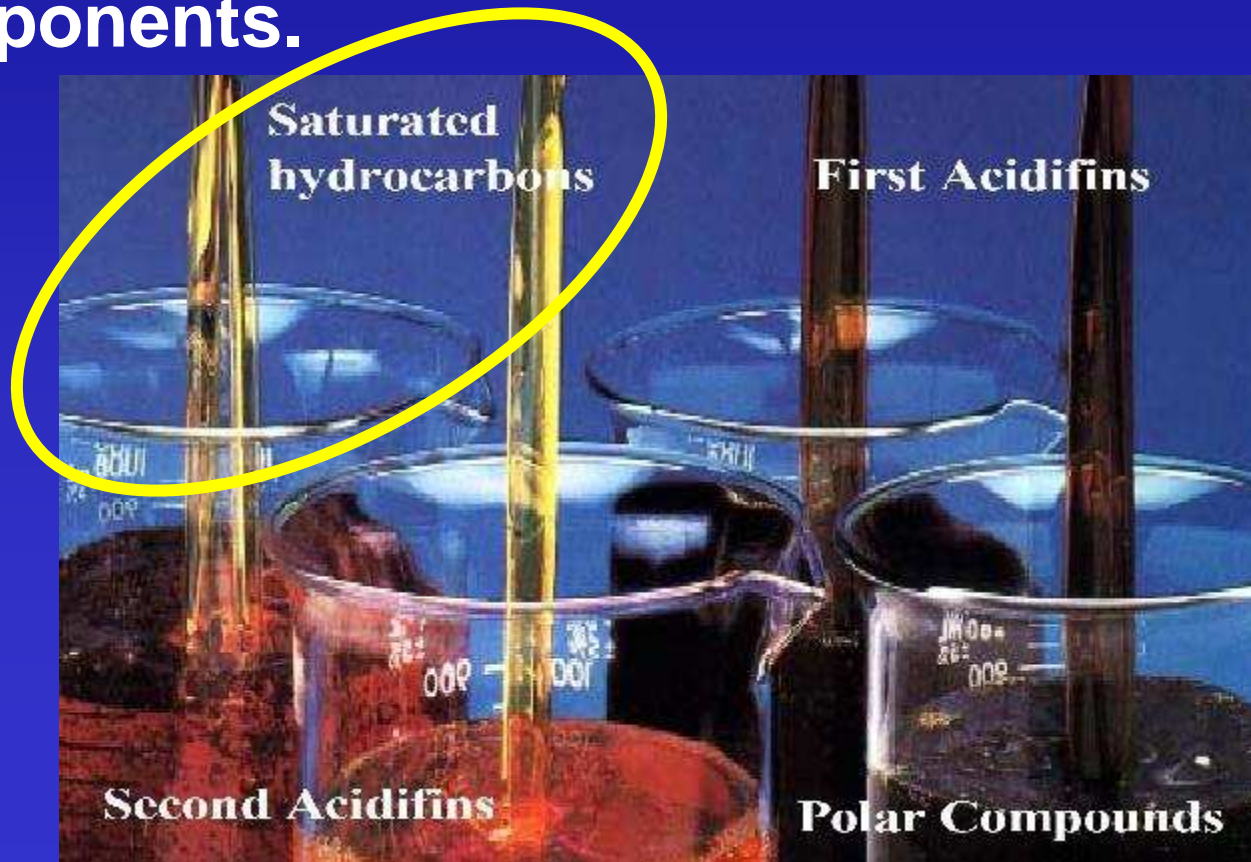
These four bodies are:

3) Second acidifins (A2) - components of slightly unsaturated hydrocarbons that also serve as a solvent for the peptized asphaltenes.

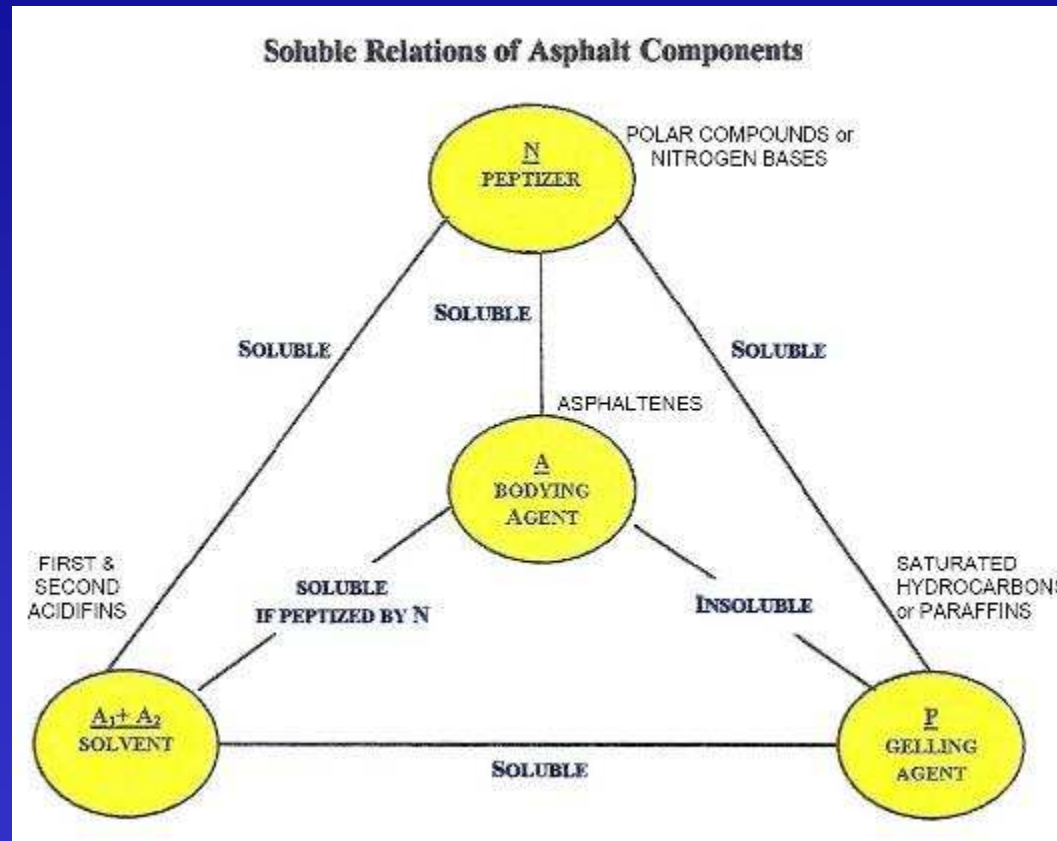


The last of the four bodies are:

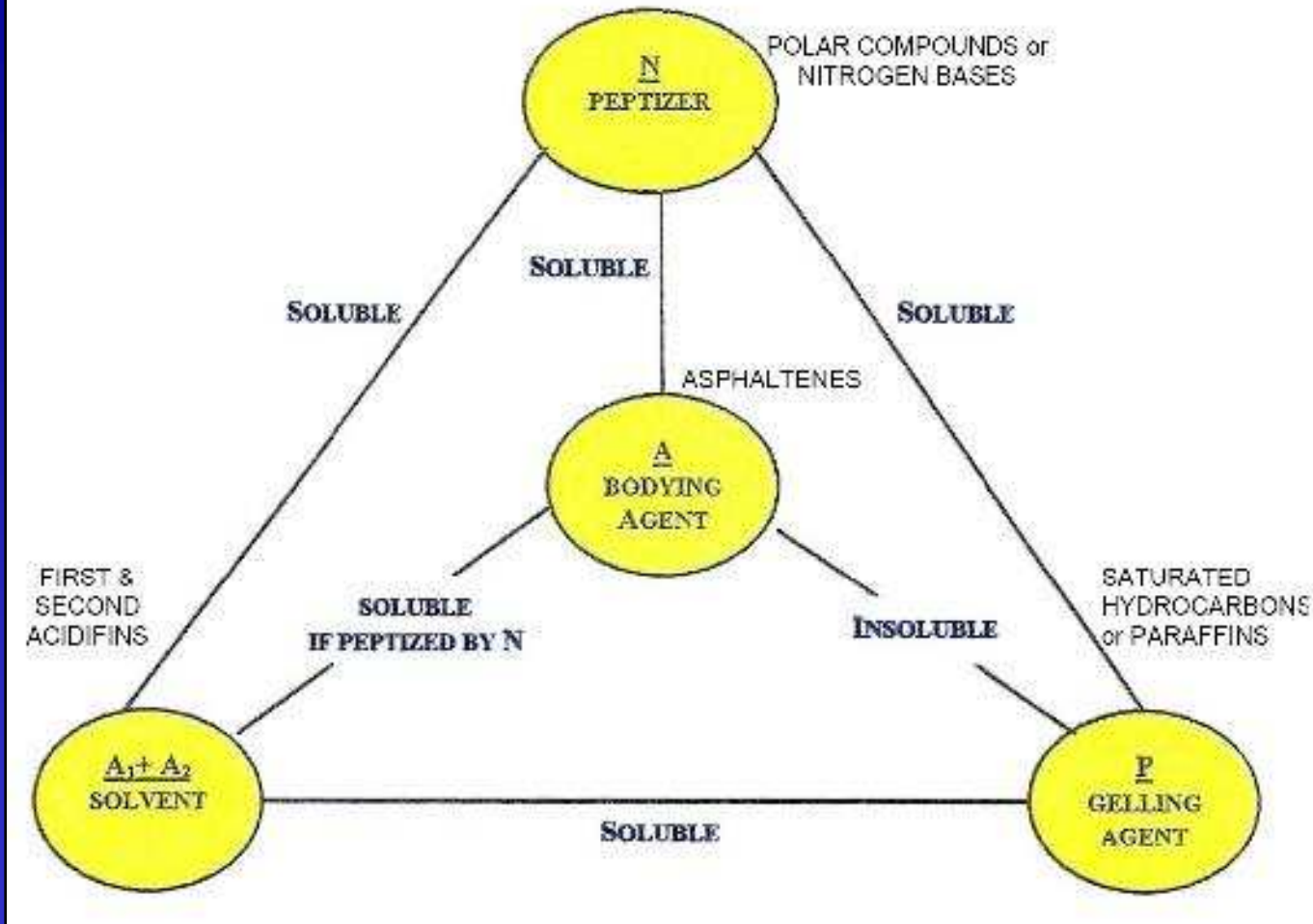
4) Saturated hydrocarbons or paraffins (P) – components of hydrocarbons, which function as a jelling agent for the asphalt components.



What is the relation between the Asphaltenes and the Maltenes?



Soluble Relations of Asphalt Components



A combined with N allows A₁+A₂ and P to mix, with A-N holding A in solution as long as balanced ratios of A-to-N and N-to-P are maintained.

In a 2000 report on rejuvenators prepared by the Asphalt Institute's Dr. Robert Boyer he discusses this and noted :

“In tests conducted by Rostler and White, it was reported that the "A" and "P" asphalt components were the most stable; and the "N", "A1", and "A2" components were more subject to oxidation in descending order, respectively.

Asphalt Rejuvenators
“Fact, or Fable”

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Consequently, during oxidation the "N" components convert to "A" components rapidly, while the conversion process for the "A1" and "A2" components proceed at a slower rate.

This process results in an increase in the "A" fraction of asphalt with time, and decreases the "N", "A1", and "A2" components.

It was also reported the "the maltenes parameter $(N+A1)/(P+A2)$, the ratio of chemically more active to less reactive components present in the asphalt binder, is a measure of predictable durability."

Simply stated, the report confirmed what other reports and studies had shown which is that the **Asphaltenes are the stable component** in asphalt cement and are unaffected by oxidation, air, UV rays, water, temperature change, etc.

Maltenes are the unstable component of asphalt cement and they are affected by air, UV rays, water, temperature changes, etc.

It is the loss of the maltenes from the asphalt cement in the upper 3/8"-1/2" of asphalt pavements that start the asphalt deterioration process.

The aging and breakdown of asphalt cement and loss of maltenes actually begins at the hot-mix plant due to the extreme heating necessary to blend asphalt cement with stone and to get it to the job site in a pliable state.

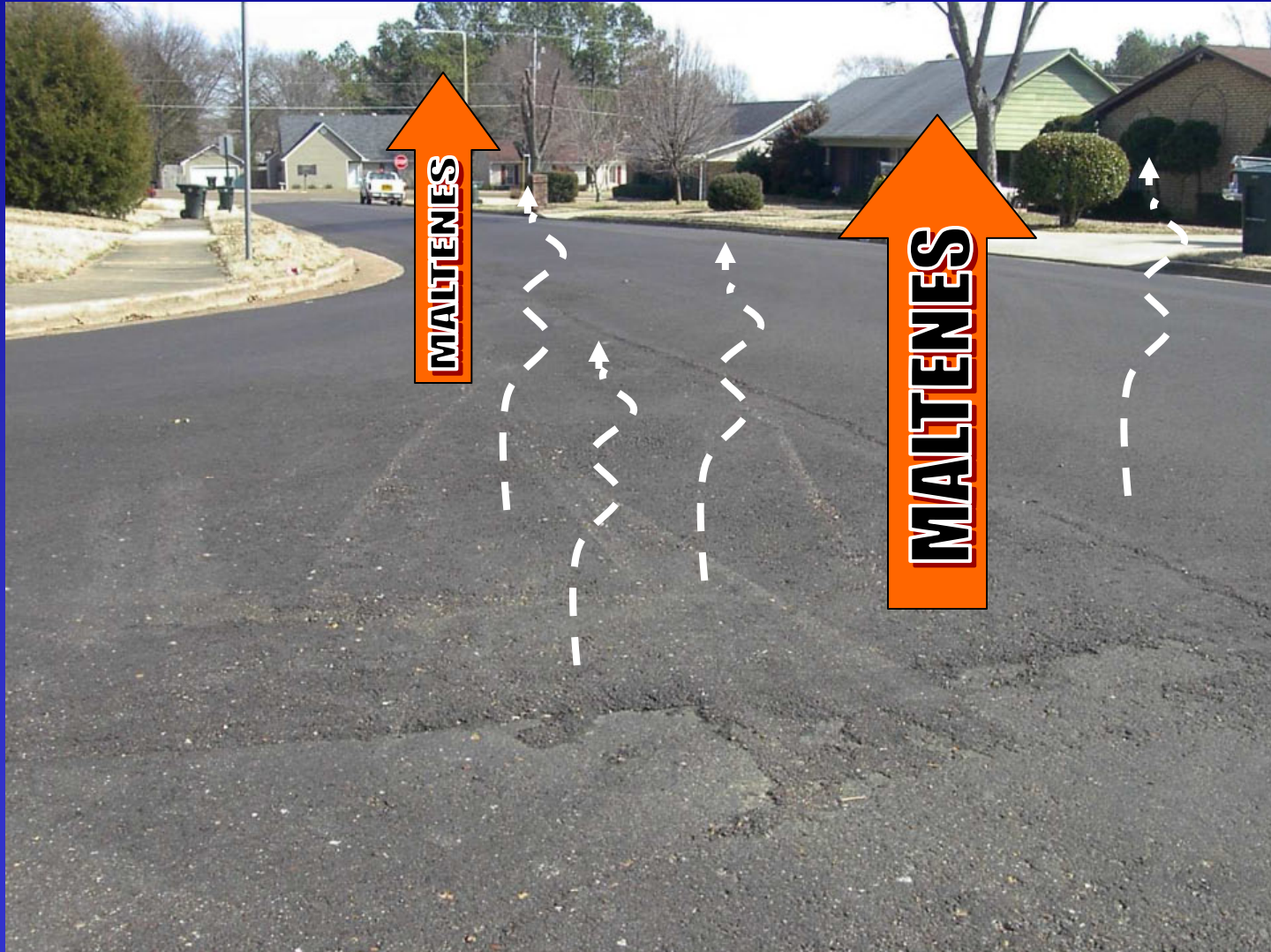


AC deterioration continues once the asphalt mixture is placed on a roadway due to :

- **Constant exposure to the Sun's UV rays**
- **Environmental temperatures**
- **Oxidation**
- **Stripping action of storm water and melting snow**
- **Traffic wear**



The constant UV ray exposure and heating effect from the sun cause the maltene fractions to be baked or oxidized from the pavement's AC.



This is why a new pavement looks like this.....



a one year old pavement looks like this.....



a 15 year old pavement looks like this.....



and a 20 year old pavement looks like this!



Fog Seal REJUVENATORS

A true fog seal REJUVENATOR is a maltene based emulsion comprised of the same maltene fractions found in asphalt cement.



Fog Seal REJUVENATORS

A rejuvenator “base oil” is formed by adding the maltene components together. Then an emulsifying agent is added to the base oil to allow the base oil to be diluted with water for application.



Fog Seal REJUVENATORS

After the rejuvenator is applied to the pavement, the water evaporates and the rejuvenator penetrates down into the pavement where it fluxes with the AC binder restoring the lost maltenes. As a result the Asphaltene to Maltene ratio is brought back to near its original level.



Fog Seal REJUVENATORS

The maltene base rejuvenator acts somewhat like a conditioner and restores the pavement's flexibility and resistance to cracking and the AC binder's cohesive ability to retain aggregate.

This type of fog seal rejuvenator essentially makes the pavement “act new”.



Fog Seal REJUVENATORS

Thus, the function of a REJUVENATOR is to “rejuvenate” the aged asphalt cement thereby restoring the pavement surface’s flexibility and the AC’s cohesive ability to retain aggregate and to seal the surface.

Fog Seal REJUVENATORS

Fog seal REJUVENATORS tested and reported on in the recently completed FHWA/FP2 Sealer/Rejuvenator Study included the following:

Reclamite® - Maltene base. First produced, tested and marketed in the late 1960's.

PASS®-QB - Polymerized asphalt emulsion with some maltene base oil content.

CRF® - Maltene based restorative seal with some asphaltene content.

ERA-1 & ERA-25 - Blends of asphalt with the same rejuvenator base oil used for Reclamite.

Other maltene based rejuvenators available include: JOINTBOND®, Cyclogen® ME, and ERA-50.

Fog Seal REJUVENATORS

Non-maltene coal tar based products marketed as rejuvenators over the past several years include:

BPR, PDC, Topien-C, Rejuvaseal, and Aspen RT

These products are more often used around airports due to the coal tar's resistance to damage from fuel oils. Many agencies now shy away from the use of these products on parking lots or roadways due to their coal tar content.

Fog Seal COATINGS

Fog seal “COATINGS”, often referred to as Sealers, Seal Coats and/or Bituminous Seal Coats are emulsions used for a variety of applications, including:

- **Sealing** of dense mix HMA from water and oxygen infiltration,
- **Re-coating** of raveling open-graded mixes,
- **Adhering** loose aggregates on freshly applied chip seals,
- **Stoppage of raveling** on older HMA pavements.

Fog Seal COATINGS

Fog seal COATINGS are also sometimes used to provide:

- **Colored contrast delineation of paved shoulders,**
- **Temporary cosmetic “new black” appearance for some streets.**

Fog Seal COATINGS

Gayle King, Project Manager of the recent FHWA/FP2 Sealer/Binder Study noted in his Final Report:

“Such products are frequently formulated with polymers or other additives as needs dictate.

Although not meant to soften the underlying asphalt, the new binder can serve as a sacrificial layer that has a lower stiffness than the aged asphalt on the pavement surface, thus protecting the underlying surface from further deterioration, especially raveling and top-down cracking.”

Fog Seal COATINGS

He further noted:

“Unlike the clay-stabilized coal tar or asphalt-based sealer products used for driveways and parking lots, this type of sealer needs to infiltrate the surface to provide the desired sealing.”

Fog Seal COATINGS

Fog seal applied Sealer products used in the FHWA/FP2 study included:

- **CSS-1h, CSS-1, CQS-1h and SS-1h** - the participating D.O.T.'s standard fog seal emulsions that met the state or AASHTO M-140 (anionic) and M-208 (cationic) specifications.
- **CRS-2Pd** - a diluted rapid-setting, polymer modified emulsion
- **LD-7** - a specialized asphalt emulsion originally developed to be a fast-curing trackless tack coat.
- **GSB Sealer Binder** - Gilsonite based emulsion Type B used only on one Minnesota test.

Fog Seal COATINGS

There are also numerous other types of asphalt and coal tar based sealers that are used as fog seal coatings for various purposes.

The study's Final Report lists an assortment of many of these products.

The report is available for viewing or downloading on the *National Center for Pavement Preservation's* web site located at www.pavementpreservation.org.

NEW PRODUCTS

The escalated cost of asphalt and resurfacing have prompted the introduction of various new products marketed as rejuvenators during the past 3-5 years.

There appears to be no independent research or test study results for some of these new products, or at least any that are readily accessible.

Without such reports being available, agencies should use caution if deciding to use any product that has no time proven or tested performance results.

IMPACT ON SKID RESISTANCE

Fog seal rejuvenators and sealers will lower skid numbers.

Experience has shown that the maltene base rejuvenators cause a shorter lasting and often less reduction in skid numbers.

Fog seal coating products have shown to cause a much longer lasting and sometimes permanent reduction in skid numbers.

Temporary application of sand at 1 to 2 lb/sy can normally improve skid resistance.

IMPACT ON SKID RESISTANCE

It is recommended that all pavements to be treated have skid testing conducted PRIOR to application of any fog seal product to determine if the pavement is a good candidate for treatment.

Lower speed residential streets pose less of a concern as they typically have 25 mph speed limits.

CAUTION must be used in choosing the pavements to be treated with the selected fog seal product and in its application rate.

IMPACT ON SKID RESISTANCE

Problems some agencies have experienced in the past were attributed to the use of unqualified contractors who had little or no experience in the application of fog seal rejuvenators or sealers.

As a result, some agencies have either halted use of fog seals or have declined to use them in light of other agencies problems they been made aware of.

IMPACT ON SKID RESISTANCE

The proper application of these products is best performed by contractors that have received adequate training and solely specialize in the application of the products.

A qualified contractor will know what pavements it can or cannot treat and what application rates and mixtures will provide satisfactory and safe results.

A qualified contractor will shy away from treating any questionable pavement.

IMPACT ON SKID RESISTANCE

Excessive application rates of Seal Coatings can cause unacceptable skid numbers and is sometimes difficult to correct.



IMPACT ON SKID RESISTANCE

Skid concerns with topical coating Seal Coats are applied on pavements with rough textures such as those with severe raveling.





SUITABLE PAVEMENTS FOR REJUVENATOR AND SEAL COAT APPLICATION

“IDEAL” LOCATIONS (Safest):

- Lower speed urban streets and rural roads (Less than 40 mph)
- Chip sealed surfaces (lighter volumes of rejuvenator may be necessary)
- Highway paved shoulders, particularly those containing milled or depressed rumble strips.
- Open Graded Mix surfaces

NOTE: Multiple studies have indicated that pavements to be treated should have a minimum 7%-8% voids in the total mixture (VTM) to allow proper penetration.

SUITABLE PAVEMENTS FOR REJUVENATOR AND SEAL COAT APPLICATION

OTHER LOCATIONS:

- **Low Volume rural roads with max. 50 mph speeds** - Special caution must be used along with lower initial application rates to assure minimal impact on skid numbers.

LOCATIONS WITH EXTREME CAUTION:

- **Lower Volume roads with speeds greater than 50 mph.** - Treat only those pavements with high skid numbers so that skid numbers after treatment will remain at allowable levels.
- **Pavements With Low Voids** - Initially treat only a small length using application rates much lower than normal and monitor for proper penetration or curing prior to continuing further application.

PAVEMENTS NOT SUITABLE FOR REJUVENATOR AND SEAL COAT APPLICATION

High Speed Roadways or Expressways

- Interstate, expressway or other high speed roadway traffic lanes should generally not be considered for treatment.

(They could be treated under specially controlled conditions.)

PAVEMENTS NOT SUITABLE FOR REJUVENATOR AND SEAL COAT APPLICATION

Roadways with excessive amounts of
pavement distress.

- Pavements with numerous areas of base failure.
- Pavements with excessive amounts of alligator cracking unless these areas are repaired prior to the fog seal application.

Paved Shoulders are excellent candidates for fog seal Rejuvenators and/or Seal Coats.



Residential streets are excellent candidates for fog seal Rejuvenators or Seal Coats.



Urban collector streets are excellent candidates for fog seal Rejuvenators or Seal Coats.



Low Volume rural roads can be excellent candidates for fog seal Rejuvenators or Seal Coats.



Newly constructed Longitudinal Paving Joints are excellent candidates for a maltene based fog seal applied Joint Stabilizer.



APPLICATION PRACTICES

Project Pavement Selections

- Rejuvenators -

Pavements selected for treatment with maltene based rejuvenator products should be in good to excellent condition to provide maximum life extension.

Typically pavements from 1 to 5 years of age are excellent candidates as they typically are relatively free of cracking and raveling.

APPLICATION PRACTICES

Project Pavement Selections

- Rejuvenators -

Older pavements can also be considered as long as they have minimal amounts of cracking and raveling.

Pavements with lower than 7%-8% void content can be treated with caution and monitoring/adjustment of application spray rates to provide acceptable product penetration into the pavement.

APPLICATION PRACTICES

Project Pavement Selections

- **Seal Coats -**

Pavements selected for treatment with seal coat products should be in fair to good to condition to provide maximum life extension.

Typically pavements from 7 to 10 years of age are excellent candidates and can benefit from these products abilities to enrich and/or fill voids left from severe raveling of surface aggregates and ability to provide minimal filling and sealing of cracks.

APPLICATION PRACTICES

Project Pavement Selections

- **Seal Coats** -

Newer pavements can be considered as long as their existing surface texture will allow for treatment with the selected product and still retain satisfactory skid resistance.

APPLICATION PRACTICES

Weather Limitations

AMBIENT TEMPERATURES

- Rejuvenators -

Maltene based rejuvenators are normally best applied when ambient temperatures are in the range of 50°F and rising.

Higher temperatures allow these products to penetrate quicker into the pavement.

Lower temperatures slow penetration times, however, as necessary these products can be heated as a means of getting faster penetration in lower temperatures.

APPLICATION PRACTICES

Weather Limitations

AMBIENT TEMPERATURES

- Seal Coats -

Depending on the type of sealer being applied these products normally are best applied when ambient temperatures are in the range of 50°F and rising.

Maximum ambient temperature limits of 75°-80°F may be necessary in areas with humidity levels greater than 50% in order to obtain acceptable cure times and minimize the time required for lane closures.

APPLICATION PRACTICES

Weather Limitations

AMBIENT TEMPERATURES

- **Both Rejuvenator and Seal Coat applications should be avoided when low temperatures below 32°F are expected.**

APPLICATION PRACTICES

Weather Limitations

PRECIPITATION

- Both rejuvenators and seal coats require dry pavement conditions for proper application.
- Application of both rejuvenators and seal coats should be avoided when there is more than a 50% chance of rain in the weather forecast.

APPLICATION PRACTICES

Weather Limitations

PRECIPITATION

- Application may be conducted with extreme caution and consistent weather monitoring when the chance of precipitation is between 25% to 50%.
- Application can be conducted when the chance of precipitation is less than 25%. However, weather conditions should be monitored and application ceased if precipitation threatens.

APPLICATION PRACTICES

TRAFFIC CONTROL

- **Lane closure permits and notices should be acquired and distributed in advance of the work.**
- **Work Zone signage and traffic control should be conducted in accordance with MUTCD and other agency required guidelines.**

APPLICATION PRACTICES

Pavement Surface Conditions

Pavement surfaces to be treated should be dry and free of all dirt, sediments and other debris prior to application of the fog seal product.

Contract documents should specify whether the agency or the contractor is responsible for sweeping and cleaning of the pavement surface prior to the fog seal application.

APPLICATION PRACTICES

SPRAY TRUCK OPERATION

- The pump output should be checked to verify that application rates comply with control switch settings.
- All nozzles should be checked to assure they are free of clogs.

APPLICATION PRACTICES

SPRAY TRUCK OPERATION

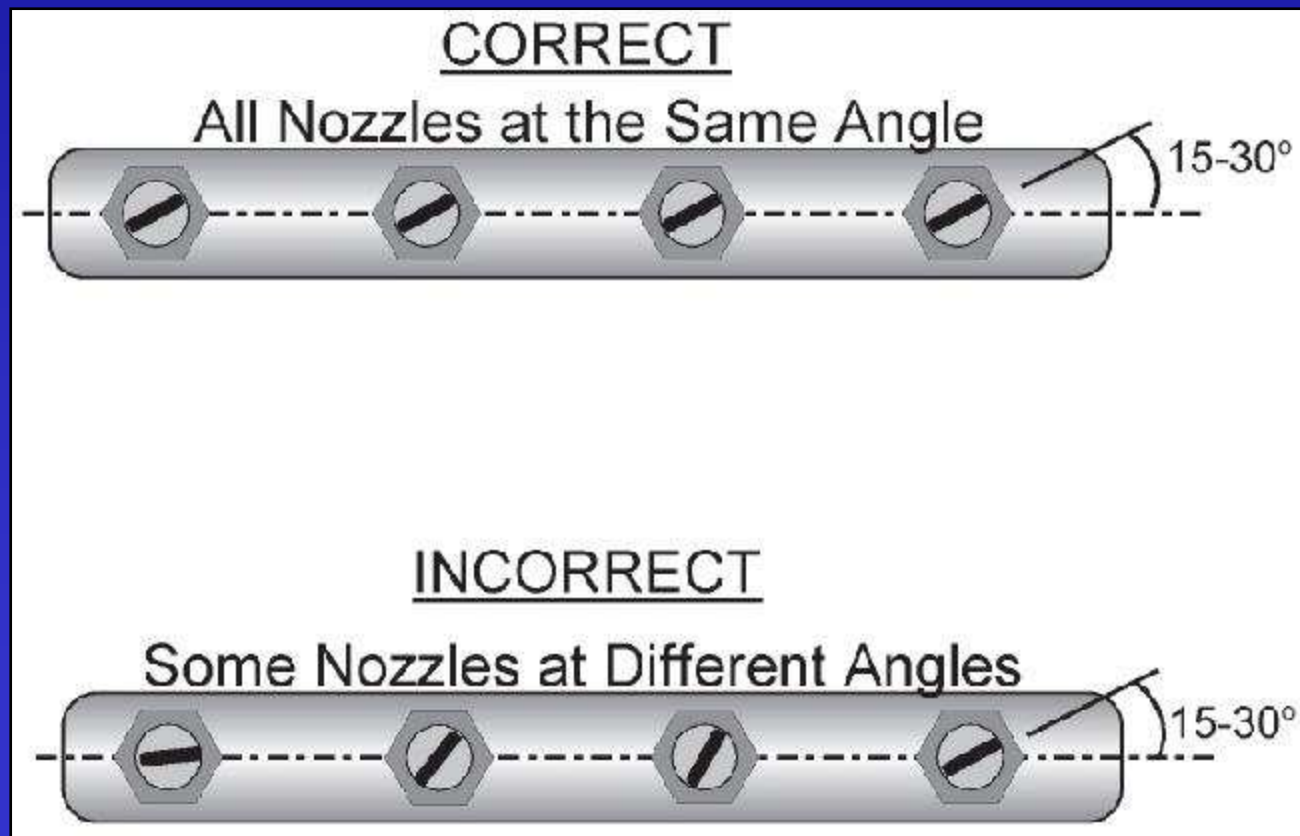
- Clogged nozzles leave streaks of untreated pavement.



APPLICATION PRACTICES

SPRAY TRUCK OPERATION

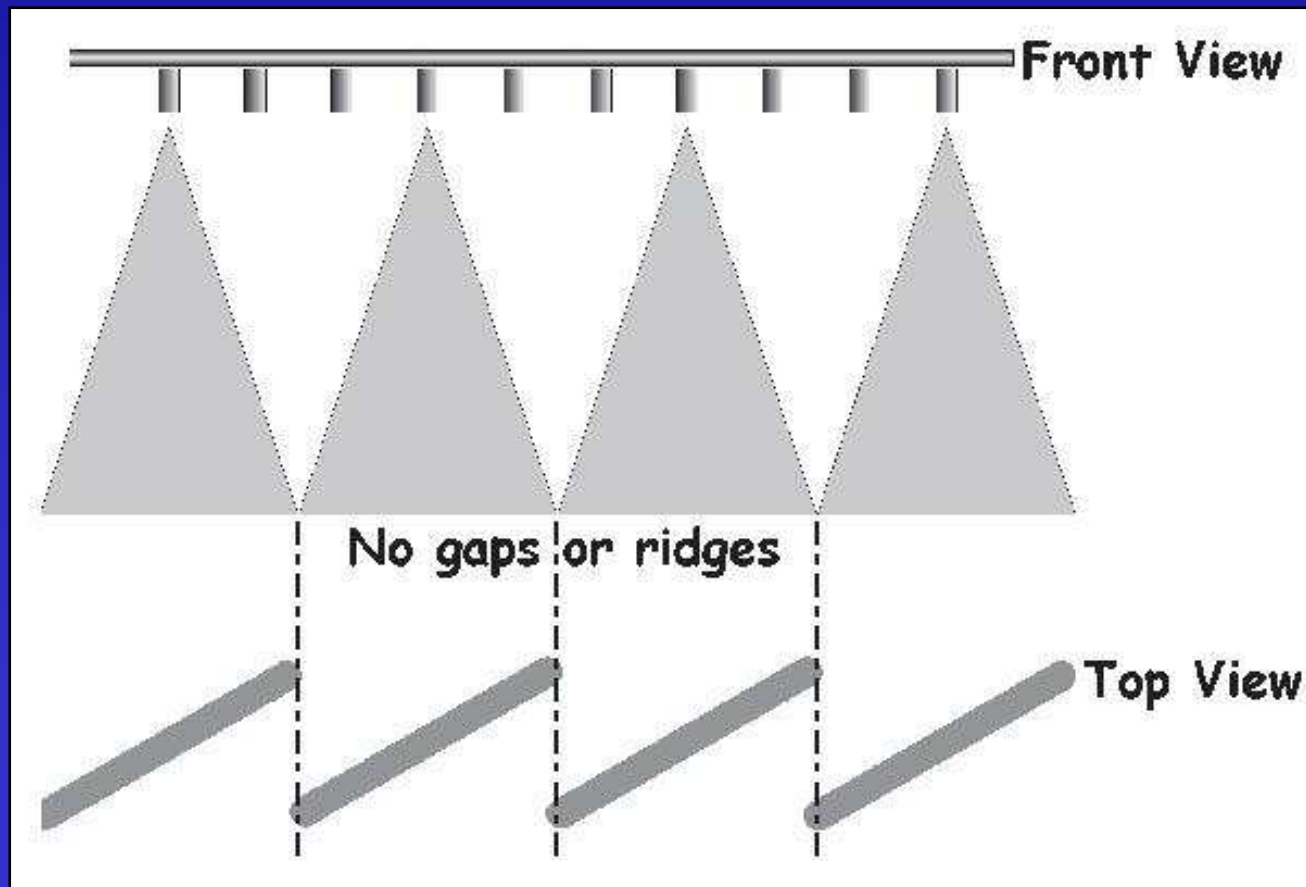
- All nozzles should be checked to verify they are all set at the same angle, typically at 15° - 30° from the bar.



APPLICATION PRACTICES

SPRAY TRUCK OPERATION

- Spray pattern should be checked to verify uniformity and proper overlap.



APPLICATION PRACTICES

SPRAY TRUCK OPERATION

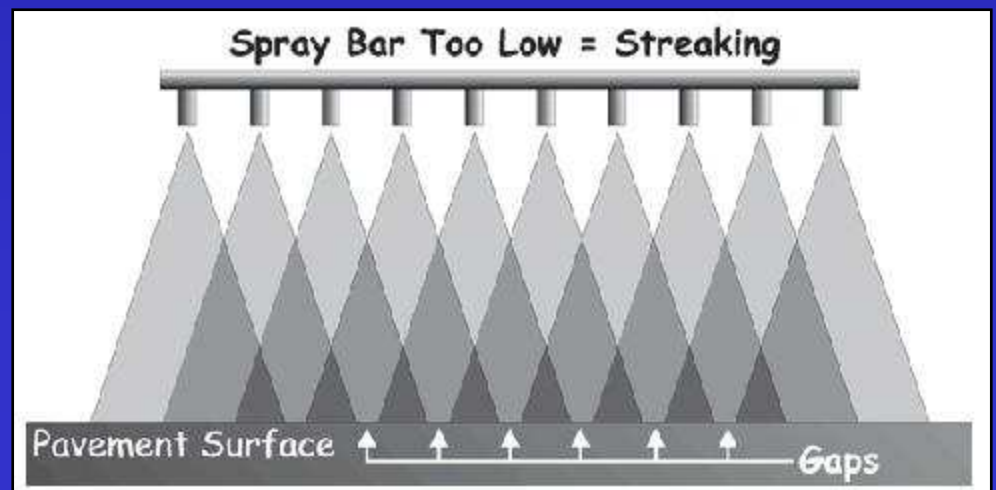
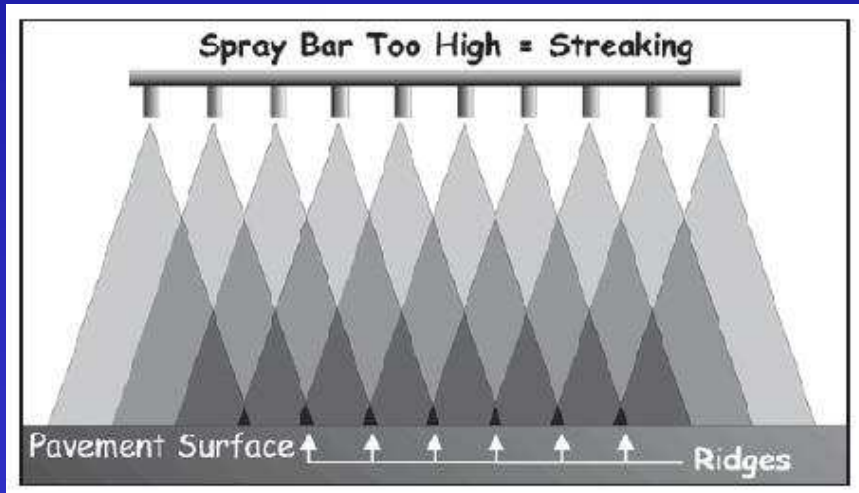
- Spray pattern should be checked to verify uniformity and proper overlap.



APPLICATION PRACTICES

SPRAY TRUCK OPERATION

- The spray bar height should be checked to verify it is at the correct distance off the pavement surface.



APPLICATION PRACTICES

SPRAY TRUCK OPERATION

- The bar being too high or too low will result in a streaking application.



APPLICATION PRACTICES

SPRAY APPLICATION RATES

- **REJUVENATORS**

Typically diluted with a 2:1 product to water ratio, but may be diluted 60/40 depending on temperature and humidity conditions.

Normal Application Rates:

.07 to .12 gal/SY depending on the pavement absorption level.

A simple “ring test” can be performed prior to application to determine needed application rate.

APPLICATION PRACTICES

SPRAY APPLICATION RATES

- **REJUVENATORS**

A simple “ring test” can be performed prior to application to determine needed application rate.



APPLICATION PRACTICES

SPRAY APPLICATION RATES

- **REJUVENATORS**

A simple “ring test” can be performed prior to application to determine needed application rate.



APPLICATION PRACTICES

SPRAY APPLICATION RATES

- **SEAL COATS**

Typically emulsions are diluted with a 1:1 product to water ratio, depending on the actual product being used.

Normal Application Rates:

.03 to .12 gal/SY depending on the pavement texture and void content.

APPLICATION PRACTICES

SPRAY APPLICATION RATES

- **SEAL COATS**

Some agencies use a test similar to the “ring test” to get an idea of what the application rate should be in order to avoid “over shooting” the pavement resulting in longer cure time and unacceptable reductions in skid resistance.

Others simply advise contractors to do a short test spray at a light application rate and then increase the rate on subsequent tests until the desired coating level is attained.

BENEFITS & RESULTS
FROM USAGE OF FOG SEAL APPLIED
REJUVENATORS & SEALERS

BENEFITS & RESULTS

REJUVENATORS

Maltene based rejuvenators work by changing the chemistry of the asphalt cement binder by replenishing the lost maltenes back into the asphalt cement restoring its asphaltene to maltene ratio back to nearly new levels.

This in turn softens the pavement surface restoring its flexibility and resistance to cracking.

It also restores the cohesive ability of the asphalt cement to retain aggregate, thereby preventing further raveling.

BENEFITS & RESULTS

REJUVENATORS

These products also work to provide a long lasting seal of the pavement's surface preventing the intrusion of air and moisture into it.



BENEFITS & RESULTS

REJUVENATORS

Pure maltene based rejuvenators are translucent and leave pavement markings visible with no need for restriping.



BENEFITS & RESULTS

REJUVENATORS

This test area demonstrates the long term effectiveness of a maltene based rejuvenator.



BENEFITS & RESULTS

REJUVENATORS

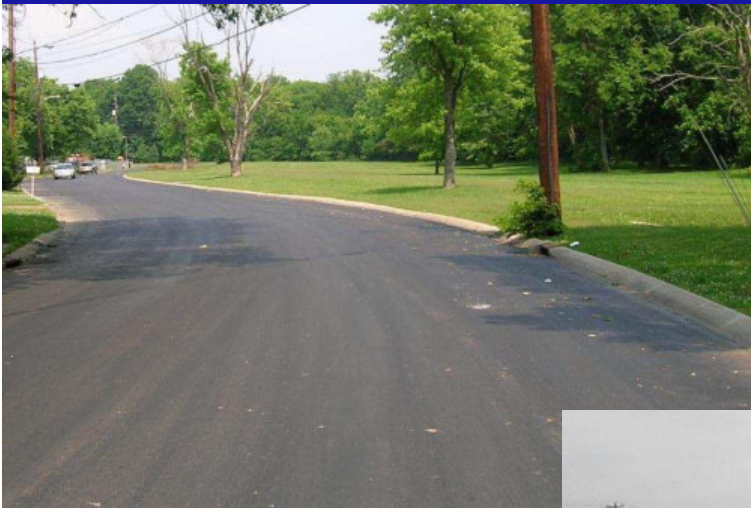
Maltene based, fog seal applied longitudinal joint stabilizers provide sealing and increased density along joints.



BENEFITS & RESULTS

SEAL COATS

Seal coats seal a pavement's surface and provide a temporary blackening of pavements.



BENEFITS & RESULTS

SEAL COATS

These sealers work to fill the voids in a raveled pavement's surface, lock in remaining surface aggregate and seal minor cracking. They seal the surface and help to prevent oxidation and further loss of maltenes. They do not replenish maltenes.



CONCERNS

REJUVENATORS

If used on tight, impermeable pavements, the oil may remain on the surface, leaving a surface that may exhibit poor skid resistance. This is normally corrected if sand or slag is applied over the treated surface at 1 to 2 lbs/SY.

The lower skid numbers typically return to normal or acceptable levels within 3-4 days, much quicker than the lower skid numbers associated with seal coats.

Tracking of residue typically occurs onto untreated surfaces. However, the tracking normally wears and fades away within 2-4 weeks.

CONCERNS

SEAL COATS

Generally reduce skid numbers by a minimum of 10%-15%, much more than the reduction caused by rejuvenators.

If applied to a tight pavement surface, more severe reduction of skid numbers can result.

Due to the void filling by the seal coats, the lowered skid resistance can last several months or longer and the pavement may not be a candidate for subsequent retreatments.

Depending on the product used and temperature and humidity levels, the cure time for seal coats can be 4-5 hours or longer.

Seal Coats cover up pavement striping and markings resulting in the need and cost for restriping.

CONCERNS

SEAL COATS

Longer cure times require that traffic be kept off the treated pavement for longer periods than a rejuvenator treated pavement.

Dark tracking from any tacky, uncured surface can occur. This is a particular problem if it is tracked onto concrete driveways and other untreated surfaces as the tracking can last several weeks or longer.



This is more of a problem in areas with humidity levels over 50% and can sometimes be addressed by limiting applications to times when high temperatures are below 75-80 F.

CONCERNS

SEAL COATS

The “new black pavement” color typically only last from several months up to a year or so as the coating material is quickly worn off the exposed aggregate in the pavement surface.

As such, the new pavement look and color delineating affect for treated shoulders goes away fairly soon.



CONCERNS

SEAL COATS

The “new black pavement” color typically only last from several months up to a year or so as the coating material is quickly worn off the exposed aggregate in the pavement surface.

As such, the new pavement look and color delineating affect for treated shoulders goes away fairly soon.



COST OF APPLICATION

REJUVENATORS

Depending on the geographic area and the size of the project, the average cost for labor, equipment and materials is approximately:

\$0.65 - \$0.75 Per SY

or

\$4,200 - \$4,800 Per Lane Mile (11'w)

COST OF APPLICATION

SEAL COATS

Depending on the type of sealer used, the geographic area and the size of the project, the average cost for labor, equipment and materials is approximately:

\$0.75 - \$1.05 Per SY, or

\$4,800 - \$6,800 Per Lane Mile (11'w)

SUMMARY

- **Fog seal applied Rejuvenators and Seal Coats are inexpensive and very cost effective means for extending the life of asphalt pavements.**
- **Maltene based rejuvenator application has been used for over 35 years and has a documented, time tested and proven history of effectiveness.**
- **Rejuvenators and seal coats are probably the most underutilized of all pavement preservation and maintenance tools.**

SUMMARY

- Rejuvenators and seal coats are both Fog Seal applied products but are not the same.
- Maltene based Rejuvenators work by changing the chemistry of the asphalt cement back to new or nearly new condition.
- Rejuvenators seal the pavement's surface, restore its flexibility and restore the asphalt cement's cohesive ability to act as a glue and retain aggregate.

SUMMARY

- **Seal Coats or Sealers are asphalt based products, generally in emulsified forms.**
- **There are various brands and types of Seal Coat products available.**
- **Seal Coats work by enriching a pavement's surface with a new coating that fills voids and lock remaining aggregate in place .**
- **Seal Coats seal a pavement's surface and help prevent further oxidation and loss of maltenes.**

SUMMARY

- **Both Rejuvenators and Seal Coats can be a cost effective and safe means of extending pavement life when properly applied by qualified contractors and/or personnel.**
- **Rejuvenators cost approximately \$4,200 - \$4,800 per lane mile applied.**
- **Seal Coats cost approximately \$4,800-\$6,800 per lane mile applied.**

References

- “FHWA/FP2 Sealer/Binder Study”, 2007, Gayle King, Project Manager, GHK, Inc.
- “Asphalt Rejuvenators - Fact or Fable”, August 2000, Robert Boyer, Asphalt Institute.
- “Preventive Maintenance of Asphalt Concrete Pavements”, January 1998, E. Ray Brown, National Center for Asphalt Technology.

Questions or Comments ?

