

Fountain of Youth: Asphalt Maltene Rejuvenators Add Life to Pavements

The old saying that bituminous pavements start out black, and portland cement concrete pavements start out white, but both turn gray in the long run has merit because it's true. Asphalt pavements lose essential bituminous components as they age, turning black to gray, while concrete just darkens.

That loss of essential components is more than a cosmetic issue; the characteristics of an aged pavement are cracking, brittleness and loss of aggregate and oxidation, which together will compromise service life and pavement condition index number. For pavements that are in fair but not deteriorating condition, maltene-based rejuvenators applied as an emulsion can constitute the "right treatment, for the right road, at the right time."

"When asphalt binder is exposed to oxygen and the sun's ultraviolet rays, it begins to age and oxidize," say Richard Willis, Ph.D., and Nam H. Tran, Ph.D., P.E., National Center for Asphalt Technology, in their article *Rejuvenators Bring Back Life to Aging Asphalt Pavements* (*Asphalt*

Pavement, July/August 2015). "The changes that occur to asphalt binders are primarily due to the chemical composition of the asphalt."

These changes take place in both short- and long-term stages, they say. Short-term aging is due mostly to the evaporation of volatile hydrocarbon compounds from the binder, oxidation or absorption of what they call "oily" components during the heat of production. Long-term aging takes place once the pavement is in the field, and is due to the reaction of asphalt components and oxygen in the atmosphere.

"These aging processes leave binders stiffer, less ductile, and with lower temperature susceptibility than conventional paving grade asphalts," Willis and Tran say. "The aging process reduces the ratio of oily maltenes in the binder, leaving a greater ratio of stiffer asphaltenes, which cause the asphalt binder to become less ductile. These viscosity and elasticity changes result in a hardened, brittle asphalt binder."

MALTENES AND ASPHALTENES

The key to understanding how maltene-based rejuvenator emulsions work is knowledge of what maltenes and asphaltenes are.

"What's left after refining and distillation of crude oil are the heavy resins at the bottom of the crude barrel, or asphalt," says Colin Durante, president, Pavement Technology, Inc., Westlake, Ohio. "Asphalt is sold and supplied based on its penetration or PG grading. In our industry we emulsify asphalt with water to make various products that can be sprayed on pavements to coat and protect them [fog or chip seals], or blended with aggregates and placed as [slurry and micro surfacings]."

True maltene-based rejuvenators are different. "Consider asphalt binder," Durante says. "The binder (pen or PG grade) will have heavy and black materials in it, called asphaltenes, and light oils and resins called maltenes. The maltene-based rejuvenator, which is the only true type of rejuvenator, is a blend of four



IMAGE CREDIT: METROPOLITAN GOVERNMENT OF NASHVILLE-DAVIDSON COUNTY

Nashville has adopted the use of pavement rejuvenators like Reclamite to protect pavement that is three to five years old; pink color typical until emulsion breaks

maltene fractions with no black color to them, because it does not contain asphalt. Unlike asphalt emulsions, which protect and add binder to the surface, the maltene emulsion rejuvenator penetrates into the surface and combines with the weathered and oxidized asphalt binder holding the aggregate. It softens it, or changes its viscosity and durability."

Thus, the rejuvenator asphalt maltene-based emulsion penetrates and combines with the asphalt binder in-depth, making it sticky again so it can keep the aggregate matrix together—the result of the rebalancing of the maltene distribution ratio.

"If you spray WD-40 on a rusted bolt, it will break the surface tension and go inside and loosen it," Durante said. "The surfactant and wetting agents we put in the rejuvenator/water mixture do the same thing; they make the emulsion wetter, so it can break the surface tension of a pavement and get into the voids of the pavement matrix."

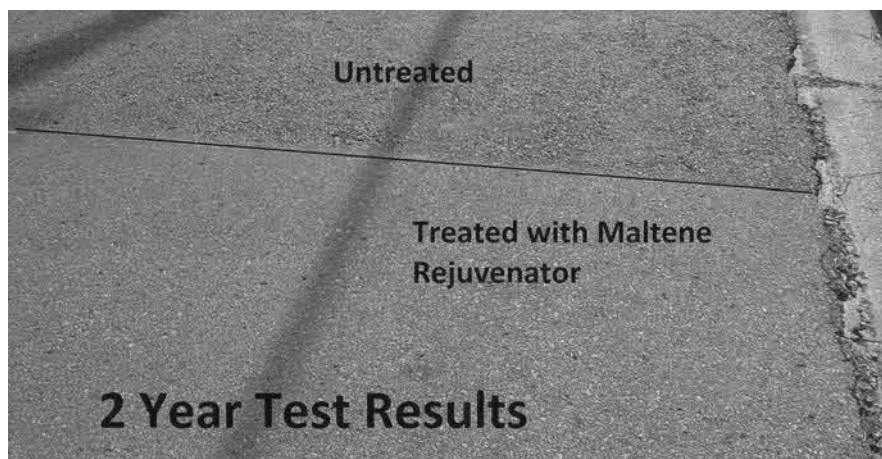
"Once the rejuvenating oils are down where you want them in the pavement," he added, "the water evaporates, leaving the maltene oils in the pavement. It's similar to how an asphalt emulsion spreads the asphalt on the surface, where the water evaporates, leaving the asphalt film where you want it."

Petroleum- or maltene-based rejuvenators aren't the only product being sold as rejuvenators. "Recently, some proprietary



IMAGE CREDIT: FPP INC.

Delegates examine absorption of maltene-petroleum based rejuvenator application at 2016 National Pavement Preservation Conference demonstration



After two years, maltene-rejuvenated pavement does not show aggregate loss compared to untreated section



After 32 years, 2009 photo shows performance of 1977 maltene-based rejuvenator emulsion-treated pavement in Cleveland, Ohio

recycling agents made from bio-based oils have been marketed and sold as rejuvenating agents," say NCAT's Willis and Tran.

"A true rejuvenator changes what's underneath, by replacing missing maltene oils and resins," Durante said. "Most of the bio-based materials are composed of various diluents derived from agricultural sources. These diluents may be an oil extract of citrus peels called d-limonene or were created from the production of bio-diesel from soy beans known as methyl soyate or methyl esters. These types of products will dissolve asphalt binder to soften it but cannot replace the natural petroleum oils and resins missing from the asphalt binder. They provide workability, softening the asphalt; but there's no improvement in durability because they can't add back the missing maltene fractions."

REJUVENATOR EMULSIONS

An asphalt emulsion is a homogeneous mixture of two insoluble substances: oil and water. In it, particles of liquid asphalt (the dispersed phase) are surrounded by molecules of water (the continuous phase).

Asphalt emulsions are produced by dispersing tiny globules of asphalt into water treated with a small quantity of emulsifying agent. The dispersion takes place in a powerful blender, called a colloid mill, where spinning blades break or shear the liquid asphalt into suspended microscopic particles. The water, or soap solution, is immediately introduced to form the emulsion.

The emulsifier—an engineered surfactant (detergent) or surface-active agent—maintains the microscopic asphalt droplets in a stable suspension, keeping them from recombining. The amount

and type of surfactant used, along with other variables, controls properties of the emulsion critical to performance in the field application.

Maltene-based rejuvenator emulsions like Reclamite aren't strictly asphalt emulsions, but they are an emulsion manufactured from a naphthenic crude stock. The naphthenic base is wax free, has a natural low pour point and has excellent solvency, allowing it to penetrate and be absorbed.

Typically rejuvenator emulsions are spray-applied at a rate of 0.04 to 0.10 gal./sq. yd.) for a diluted maltene-based rejuvenator emulsion, placed by a computerized distributor truck, according to FP² Inc. The rejuvenator restores the components of asphalt lost in the aging process, and it's designed to penetrate, flux and co-mingle with the existing asphalt binder.

"Maltene-based rejuvenators may offer a low-cost and effective pavement preservation treatment when applied correctly on pavements in newer condition, or in the mid-to-higher pavement condition index (PCI) range," FP² reports in its *Preservation Toolbox*.

As always, preservation treatments must be the right treatment, placed on the right road at the right time. Therefore rejuvenating emulsion applications should be used on mid-to-higher PCI asphalt pavements that are structurally sound. They can also be effective on aged chip seals, encouraging chip retention by slightly softening the binder and resetting the chip. They are very effective for pavement-shoulder preservation.

However, there is a limit to their performance. Rejuvenator emulsions should not be used on pavements with moderately or severely distressed surfaces, pavements with poor skid resistance or rutting, or roads that cannot be closed or partly closed to traffic during the curing period, FP² reports.

And rejuvenator emulsions, if improperly applied, may initially reduce skid resistance, especially when applied too heavily, FP² says, adding usually they are sanded to reduce friction loss.

PART OF PROGRAM

Asphalt emulsion-based rejuvenators have a place alongside chip seals and slurry surfacings in agency pavement preservation programs, experience shows.

But rejuvenators are relatively new in the game, having been introduced in the 1960s as a pavement preservation treatment. And generally, pavement management programs don't include asphalt rejuvenators within their software due to lack of that knowledge by the program developers, and due also to established histories of chip seal or slurry wear course treatments.

Travis County, Tex., has used maltene-based Reclamite rejuvenator successfully for years, said Don Ward, P.E.,

former director of road maintenance and fleet services, Travis County. and now engineering sales manager, Pavement Restoration Inc.

"Rejuvenators penetrate into aged hot mix asphalt and revitalize it," Ward said. "When we did the first neighborhood in Travis County, where Austin is located, the rejuvenator penetrated down to nearly an inch, because the pavement was fairly aged and oxidized," Ward said. "The older a structural layer is, the further it will penetrate as far as it can."



IMAGE CREDIT: PAVEMENT TECHNOLOGY, INC.

After rejuvenator placement, light coating of sand is applied to enhance friction

There's a difference between real rejuvenators and products that make a gray, aged surface look new again, he said.

"During my tenure with the county we had lots of experience with that," Ward said. "If someone had a new product they wanted us to try out, we'd do a demo with them. We had products come out that looked black for a month, and then all of a sudden, they would start to peel off the wheel paths. We'd see striations, and a year later it would be gone."

Ward did his due diligence before first using Reclamite rejuvenator in Travis County 14 years ago. "I did extensive research and traveled to a number of states to look at products applied," Ward said. "I was taken aback by how the product worked. A county in Florida had 15 years of documentation and was able to demonstrate how millions of dollars had been saved preserving pavements with maltene-based rejuvenator."

Likewise, Ward is convinced the rejuvenator saved money for Travis County. "After years of using it I am totally convinced that it saved taxpayers big money, and will save government entities—counties, cities and states—hundreds of thousands of dollars in deferred costs alone."

Also, Visalia, Calif., has successfully used maltene-based rejuvenators in its pavement preservation program since about 1990.

The City of Visalia's goal was to maintain the high street PCIs shown by its pavement management system program with a lower cost treatment, extending pavement life by four to five years. Application of an asphalt emulsion-based rejuvenator has led to increased PCIs on Visalia streets, while the city has raised the level of public awareness of pavement preservation through an in-house media promotion.

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In Visalia, the application rate varies between 0.07 to 0.10 gal per sq. yd. of the asphalt emulsion diluted with water 2:1. The job is to maximize the absorption of the rejuvenator, then allow it to cure for a minimum one to two hours, followed by sanding and mechanical sweeping within the same day or within a 24-hour period.

Penetration and viscosity testing utilizing Caltrans test methods and dynamic shear rheometer (DSR) testing showed substantial improvement in penetration and viscosity, leading to reduced stiffness of the binder and retarding the aging process. Visalia's use of rejuvenators has been so successful that it received the 2015 *Project of the Year Award* from the Western Region Association for Pavement Preservation (WRAPP, formerly the California Chip Seal Association).

REJUVENATING RAP AND RAS

Rejuvenating applications may also be used to rejuvenate good quality reclaimed asphalt pavement (RAP) millings for base placement, or for a final ride surface for lower volume rural, residential or regional road applications, FP² says, adding they can be a good choice for this purpose, as they don't over-asphalt the existing RAP binder, manufacturers say.

Asphalt emulsion-based rejuvenators can be used to improve performance of reclaimed asphalt shingles (RAS) as well.

"Rejuvenators are one way to improve some performance properties of the asphalt binders found in RAP and RAS," say NCAT's Willis and Tran. "Although research has begun on the use of rejuvenators with asphalt mixtures containing higher recycled contents in the field, there are still many questions that need to be answered regarding their use."

The Texas DOT found that rejuvenators can improve RAP mixes. "The initial work ... has shown the use of rejuvenators in recycled mixtures can

improve the cracking resistance of these mixtures without adversely affecting their resistance to moisture damage and permanent deformation," says Robert Lee, flexible pavements engineer for the Texas DOT. "In the laboratory, all of the mixtures using rejuvenators did improve the moisture susceptibility and rutting resistance of the mixtures containing recycled materials." 

Article provided by Pavement Technology, Inc.

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