

A scenic landscape featuring a paved road that recedes into the distance, flanked by rolling hills covered in trees with vibrant autumn foliage in shades of orange, red, and yellow. In the background, misty mountains rise under a soft, hazy sky. The overall atmosphere is peaceful and natural.

Corrective
Asphalt
Materials

Executive Summary

In 2024, the Minnesota cities of Woodbury, Eden Prairie, and Richfield completed an 8-year study of the Maltene Based Rejuvenator, Reclamite™. The study was conducted with Corrective Asphalt Materials (CAM). All 3 cities were early adopters of an MRT asphalt preservation program.

The goals were to document the long-term effects Reclamite has on asphalt and to determine if subsequent applications of Reclamite add value. Below, we explain the background, the process, testing data, and results.

The results prove that early application of Reclamite preserves asphalt, reduces oxidation, and decreases viscosity of the roads by adding the essential maltenes into roadways. Agencies can save additional time and money by applying Reclamite to pavement within 12 months: The sooner the application, the greater the ROI.





Background

Agencies understand that the lifespan of their asphalt pavements is decreasing, and with rising construction costs, they can no longer manage their roads the way they have for decades. Minnesota agencies were eager for additional options for pavement preservation when CAM entered the territory in 2016.

Reclamite is the original (and currently only) Maltene Replacement Technology (MRT) for restoring and preserving the durability of asphalt and is classified as an asphalt rejuvenator. Back in the early 1960s, Dr. Fritz Rostler, while working for the Golden Bear Oil Company, discovered the origin of asphalt pavement degeneration.

By separating the components of asphalt in laboratory conditions, Dr. Rostler determined that asphalt's soluble, more reactive components, known as maltenes, degrade when exposed to the heat used in processing asphalt-based formulations, and then further degrade as asphalt is exposed to the oxidizing effects of UV in field installations.

In collaboration with Golden Bear's Richard White, Dr. Rostler set about developing a technology that would restore the petroleum maltenes to aging asphalt, rejuvenating its pliability and resilience, thereby significantly improving pavement durability and extending the pavement's lifespan. Based on Rostler's research, Reclamite was developed.

Uniquely, the Reclamite rejuvenator restores the reactive maltene components that asphalt pavements lose due to hot-plant operations and the subsequent field aging process. Reclamite deeply penetrates the surface to protect against air and water intrusion. CAM helped commercialize this technology in the Midwest and South. Its application in real-world conditions began in the early 1960s.

Unlike topical sealing products, Reclamite Maltene Replacement Technology chemically adjusts the asphalt's long term binder's rheology, increasing penetration values while decreasing viscosity and corresponding DSR (Dynamic Shear Rheometer) values.

Another distinction of Reclamite is the base oil, which **is naphthenic (wax-free)**. The base oil is the vehicle that brings the maltenes to the asphalt. Paraffinic oils carry wax **and additional solvents, which are added to help the waxy oil penetrate asphalt, resulting in** lower viscosity and the sacrificing of the short-term with long-term damage and shorter roadway lifecycles. Paraffins can increase the colloidal instability of the asphalt binder resulting in the precipitation of the asphalt; in other words, the binder crystalizes and causes a phase separation that accelerates maltene oxidation.

Reclamite rejuvenator is the ideal solution for government agencies and private communities looking for a preservation solution, a partner with 50+ years of proven performance, and the highest lifecycle return on their road preservation investment.

The Problem:



Over time, asphalt pavements age and oxidize, which leaves asphalt dry and brittle. The first signs of oxidation are loss of surface fines and small aggregate, surface raveling, and hairline cracking.

Oxidation begins at the manufacturing process as high temperatures heat up the oils and start the asphalt's degradation. Natural weathering then continues oxidation via the sun and moisture. In recent years, due to poorer quality oils from refineries and the use of recycled materials (RAP, RAS, tires, etc.), pavement oxidation has increased in the first few years after asphalt is laid, shortening pavement lifecycles.

The Hypothesis

New pavement has a specific proportion of asphaltenes to maltenes; the goal of rejuvenation is to maintain the asphaltene/maltene balance in the “new” condition for as long as possible by slowing natural oxidation. Many pavement restoration products reduce viscosity temporarily but do nothing to prevent oxidation because they are only addressing short-term flexibility. As the proportion of asphaltenes increases in untreated pavement, the binder ages and will become stiff and prone to surface cracking, decreasing durability. When treated with Reclamite, which adds maltenes back into the asphalt, the pavement exhibits slowed oxidation, chemically and visually. Adding maltenes is how durability is restored. Flexibility and durability are two different measurements; flexibility can be added without adding durability.

The Testing

Reclamite uses Maltene Replacement Technology (MRT) to slow oxidation and the aging process. The asphalt binder is comprised of two components, asphaltenes and maltenes. Asphaltenes are the “bodying agent” and maltenes are the reactive components that keep the oil flexible and durable. Asphalt oxidizes as the percentage of maltene in the oil decreases over time; as the ratio of asphaltenes to maltenes in the oil grows, asphalt begins to age.

Oxidation is merely a chemical reaction in asphalt. Oxidation and the aging process can be significantly slowed by adding maltenes to the surface of the pavement, restoring the asphalt closer to its original state. MRT helps keep the surface of the pavement flexible and durable, significantly slowing the aging process.



Testing Standards

Sections of pavement in the three Minnesota cities were treated with Reclamite and were tested for three industry-accepted criteria to evaluate the product's long-term effectiveness. All testing was completed by the same third-party laboratory: APART – Asphalt Pavement & Recycling Technologies. These are the three criteria:

Long-term visual performance

Long-term relative viscosity change using MRT

(AASHTO T-315)

Long-term chemical composition of the asphalt binder

(ASTM D-2006-70)

Explanation of Testing

01

Long-term visual performance: Visual performance evaluates how treated and untreated sections of pavement look at different time intervals, such as 6 months, 1 year, 5 years, 10 years and so on. The treated surface should show fewer visual signs of raveling, hairline cracking and aggregate loss, and may appear “tighter” relative to untreated sections. Raveling is defined as a wearing away of the pavement surface in high-quality hot-mix asphalt, caused by the dislodging of aggregate particles and loss of asphalt binder. Raveling and fine aggregate loss are the first visual signs of asphalt aging. Visual performance is important because testing binder properties alone for rejuvenators can occasionally show “false positive” results.

02

Long Term Viscosity or Rheology Change: Viscosities of asphalt binders are measured with the AASHTO T-315, which uses a Dynamic Shear Rheometer (DSR). This method, also known as rheology, measures the linear viscoelastic properties (viscosity) of the asphalt binder using the DSR. Rheology testing can incorporate several different parameters and should be examined. For the purposes of this white paper, we kept the parameters simple, using only viscosity measurements.

Viscosity is measured in poises. Poises measure resistance to being bent or moved, as well as the resilience (elasticity) of the asphalt binder; a lower poise number reflects an increase in flexibility and movement of the asphalt. A stiff asphalt binder will have a higher poise number: As asphalt ages, it hardens – stiffens – so the poise increases. Keeping the oils flexible is crucial for slowing the asphalt aging process.

A rejuvenator should lower the viscosity of the asphalt binder. This suggests that the material has penetrated and combined with the existing binder to restore flexibility. Specifications typically state a minimum 30% decrease in viscosity within 60 days of the rejuvenator's application. The goal of an effective rejuvenator is to keep viscosities above the minimum level change for as long as possible.

It is imperative to increase the flexibility and durability of asphalt as it ages to slow the aging process; however, the product must do so without stripping the asphalt of its valuable oil components. Although viscosity is an important measure of a rejuvenator's effectiveness, a lower viscosity does not necessarily indicate that rejuvenation has occurred. Other materials like solvents and degreasers can dissolve the binder and reduce viscosity without replacing maltenes. A lower viscosity may indicate that the binder has improved flexibility, but does not address durability.

Chemicals such as diesel fuel, D-limonene, and linseed-based biodiesels will chemically separate and dissolve the asphalt binder and will show lower viscosities. These solvents create a short-term viscosity change and a visual difference, but do not address pavement oxidation. The visual difference is usually a surface appearance lighter in color than the untreated pavement, due to the material's dissolving the asphalt off the aggregate's surface.

Over time, some self-classified rejuvenators will age pavements at a faster rate than natural pavement oxidation; their chemical makeup causes phase separation and crystallization of the binder, which dries and dissolves, accelerating aging.

03

Long-term chemical composition: While viscosity measurements focus on flexibility, ASTM D-2006-70 results relate to durability. The purpose of this test is to measure the composition of asphalt to assess the ratio of key components using the procedure described by ASTM D-2006-70.

The binder is extracted and separated into its constituent components, asphaltenes and maltenes. Asphaltenes are comprised of the bodying (thickening) agent of the binder and typically do not degrade over time. Maltenes, the more reactive component, oxidize and become asphaltenes. The goal is to see a decrease in the percentage of asphaltenes: If asphaltenes increase, it suggests that the binder is aging.

Testing Data



The agency and CAM visually examined the testing areas and found a clear difference between the treated and untreated sections on site; evidence of raveling, surface fine loss and aggregate loss were more visible in the untreated sections. Between years 6 and 7, the viscosity and the maltene/asphaltene ratios both dropped substantially in Woodbury, as did the loss of surface aggregate and fines. Loss of fines and aggregate was much more prevalent visually in Summer 2023 than in years past, suggesting that year 6-7 is the right time for the second application.

In 2020, Woodbury allowed CAM to apply a test spot of a second application over the original roadway, four years after the initial Reclamite Application in 2016. The original application was applied one year after paving occurred in 2015. In 2022, the parties decided to core these locations as Woodbury was trying to determine when to begin a second application of Reclamite. These coring results are what led CAM to reach out to Richfield and Eden Prairie to gather additional information.

In 2022, Woodbury's first MRT application was still holding a viscosity decrease of 40% six years after application. The second application, applied in 2020, 4 years after the first application, decreased viscosity by 46%. The minimal amount of change between the first and second applications showed us in the 2022 coring that if Reclamite is applied within a year of paving, four years is too early for a second application, which can be postponed until later in the pavement's lifecycle and long-term pavement management plan.

Woodbury actively uses the Pavement Condition Index (PCI), a third-party rating system from Goodpointe Technology. Because this data brings another objective evaluation of Woodbury’s roadways, it is included in this analysis. The chart below indicates that untreated roads had a delta of 7-19 PCI points, while the treated roads’ delta was 0-3 PCI points.

The PCI ratings alone show the importance of pavement preservation, especially when done early. Eight years after paving, all of Woodbury’s treated roadways still have a rating above 90 on the PCI scale – a clear indication of success.

This chart illustrates the PCI data.

WOODBURY PCI RATINGS in 2019 and 2023

Treatment Type	Street	Construction Type	Year	Func Class	Previous CI October 2019	Current CI July 2023	Delta CI
No Treatment	Spinaker Circle	Edgemill & Overlay	2016	Local	92	83	-9
No Treatment	Spinaker Drive	Edgemill & Overlay	2016	Local	94	88	-7
No Treatment	Spinaker Drive	Edgemill & Overlay	2016	Local	97	84	-12
No Treatment	Spinaker Drive	Edgemill & Overlay	2016	Local	94	75	-19
No Treatment	Spinaker Lane	Edgemill & Overlay	2016	Local	93	84	-10
No Treatment	Sunrise Drive	Edgemill & Overlay	2016	Local	94	85	-9
No Treatment	Sunrise Drive	Edgemill & Overlay	2016	Local	94	85	-9
Reclamite	Corral Alcove	Edgemill & Overlay	2015	Local	93	93	0
Reclamite	Corral Lane	Edgemill & Overlay	2015	Local	98	95	-3
Reclamite	Corral Lane	Edgemill & Overlay	2015	Local	97	95	-2
Reclamite	Corral Lane	Edgemill & Overlay	2015	Local	95	92	-3
Reclamite	Pheasant Run Road	Edgemill & Overlay	2015	Local	100	99	-1
Reclamite	Pheasant Run Circle	Edgemill & Overlay	2015	Local	92	91	-1
Reclamite	Pheasant Run Road	Edgemill & Overlay	2015	Local	97	97	0

LONG TERM VISCOSITY- AASHTO T-315

WOODBURY, EDEN PRAIRIE, & RICHFIELD MINNESOTA

Agency	Eden Prairie	Richfield	Woodbury	Woodbury
Location of Applications	Waterford	Thomas Ave S.	Pheasant Run Rd	Pheasant Run Rd
Year Paved	2017	2015	2015	2015
When App. #1 Applied	2019	2018	2016	2016
When App. #2 Applied	2023	2023	2020	2023
Yrs between Paving & 1st App.	2	3	1	1
Year Core Taken	2023	2023	2022	2023
Yrs Between Core & 1 st App.	4	5	6	7
Yrs Between Core & 2nd App.	2 Months	1 month	2 years	2 months
1 App. Viscosity Change	37%	16%	40%	17%
2 App. Viscosity Change	53%	48%	46%	44%

The table above shows the viscosity, measured in poises, of the three Minneapolis area agencies over a period of 0-7 years. Each city chose to treat their pavements at different intervals (from 1-3 years) after paving; Woodbury chose to treat their pavements one year after the initial paving.

Eden Prairie chose to treat their pavements 2 years after paving; Richfield chose 3 years. The poise results show that treating a pavement earlier (Woodbury) was the most beneficial for slowing the aging of the pavement and the most cost-effective long-term pavement management program.

Eden Prairie Data



Figure 2: EP picture location

Eden Prairie's viscosity changes landed between Richfield's and Woodbury's. This data aligns with application timeframes and coring data.

The coring data shows that to slow the aging process of asphalt, the earlier you apply Reclamite, the more beneficial it is. It also shows that you can postpone the second application of Reclamite to 6 or 7 years if the first application is done within 1 year of paving. The earlier you apply a first application of Reclamite with MRT technology, the further you can stretch your pavement management plan – and therefore agency dollars.

Treating pavements at year 0-1 will extend the pavement's lifecycle more than waiting until year 2 or 3; this is evident in the coring results.

Richfield Data



Richfield's paving occurred in 2015, the same year as Woodbury's. Three years after the initial paving, they chose to apply the first application of Reclamite. Coring was completed in the summer of 2023, 5 years after the initial Reclamite application. The coring data indicates that the viscosity dropped to 16% upon the first application and decreased to 48% upon the second application.

Asphaltenes Table for the three agencies

Agency	Eden Prairie	Richfield	Woodbury	Woodbury
Location of Applications	Waterford	Thomas Ave S.	Pheasant Run Rd	Pheasant Run Rd
Year Paved	2017	2015	2015	2015
When App. #1 Applied	2019	2018	2016	2016
When App. #2 Applied	2023	2023	2020	2023
Yrs between Paving & 1st App.	2	3	1	1
Year Core Taken	2023	2023	2022	2023
Yrs Between Core & 1st App.	4	5	6	7
Yrs Between Core & 2nd App.	2 Months	1 month	2 years	2 months
Decrease in Asphaltenes with 1 Treatment	7.10%	4.40%	12.90%	5.90%
Decrease in Asphaltenes with 2 Treatments	13.60%	11.50%	15.40%	16.20%

The table above shows the decrease in asphaltenes in the roadways when treated with Reclamite. Specifications currently do not have a minimum decrease percentage; the goal is to keep asphaltenes as low as possible for as long as possible and to maintain the asphaltene to maltene ratio in alignment with their original chemical state as new asphalt.

By applying Reclamite early, Woodbury was able to hold the asphaltene percentage decrease with one application longer and better at 5.9% over Richfield's 4.4% change. The second application also showed a significant change versus Richfield: Woodbury's second application at year 7 decreased the asphaltene content by 16.2%, whereas in Richfield, the second application only decreased the asphaltene content by 11.5%. This shows that applying MRT technology early keeps the pavement in "like new" condition longer and allows the city to extend the second application to later in the pavement's lifecycle.

Conclusion

Long-term coring, visual results, and PCI ratings provide an understanding of Minnesota pavements and the most beneficial time for local agencies to apply and reapply Reclamite. The findings show that the sooner MRT technology is applied, the longer the roadway can wait for a second application, and that a second application is well worth the cost/benefit ratio. Woodbury chose to apply Reclamite within the first 12 months of paving; the viscosity at year 7, with a 17% change, shows that long-term sustainability was achieved and was maintained at a higher standard for a longer period of time.

Woodbury's PCI ratings showed that with the use of Reclamite Maltene Replacement Technology, an agency can maintain its roadways in good condition for a longer period of time than without. Onsite visuals were also still present in the second applications and at the very first Minnesota project. In Woodbury, a clear line between treated and untreated pavement is still visible at the 2016 pilot project intersection where a treated road crossed an untreated roadway. MRT data shows that it remains a powerful cost reduction tool for agencies, especially since resurfacing costs 12 to 15 times the cost of rejuvenation, is a huge inconvenience for the community, and impacts the agency's budget.

