Maltene Replacement Technology, Pavement Preservation and GHG Mitigation

Pavement Technology, Inc.

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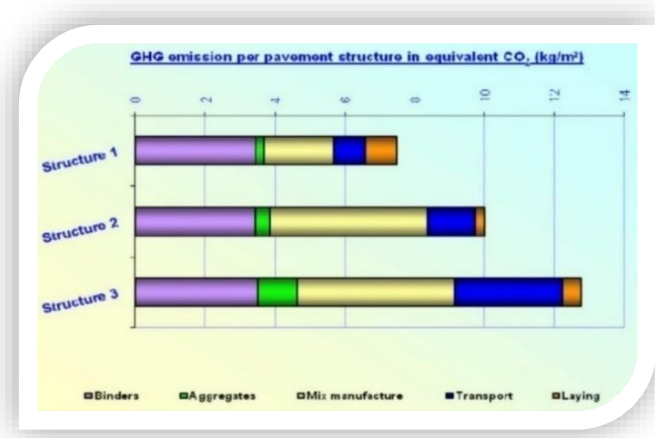
Pavement Preservation and GHG Mitigation

Asphalt remains the most durable and efficient material for roadway construction, dating back to the Romans and earlier. More than 90% of our roadways are built with asphalt.[1] The manufacturing of asphalts and construction of asphalt roads, however, have a meaningful impact on the environment, energy use and GHG emissions.

Pavement reconstruction and most forms of rehabilitation consume significant amounts of energy. From the negative RF in obtaining and processing raw materials, to mixing, transporting and finally paving (applying), the global warming potential (GWP) of building and maintaining roads is of considerable importance to sustainable urban planning and maintenance **(Figure 1)**.

Employing pavement preservation requires significantly less energy than in part or whole rebuild, of course. Fog sealing, which includes molecular replacement strategies such as MRT, uses the least amount of energy per year of extended pavement life at as little as 250 BTU/yd^2-yr (0.4 MJ/m^2-yr).[2]

Figure 1 CO_2e Emission by Asphalt Pavement Input



Source: Colas Group SA

Compare that to the energy consumption of a pavement **rebuild** consuming as much as 1.5 million BTUs or 200 MJ/m^2-yr [3] or roughly **500x the CO_2e** of pavement preservation strategies.

Beyond the enormous carbon footprint savings, the significant cost differential for preservation techniques over rebuilds provides returns on investment (ROI) typically exceeding 250%.[4]

[1] Asphalt Institute, www.asphaltinstitute.org.

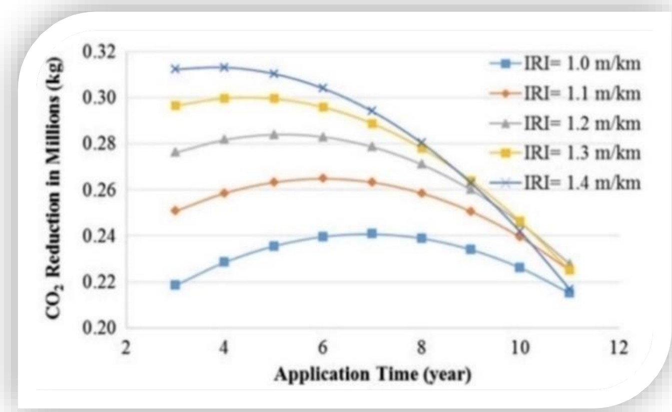
[2] Chehovits J and Galehouse L, *Energy Usage and Greenhouse Gas Emissions of Pavement Preservation Processes for Asphalt Pavements, Transportation Research Board*, 2010.

[3] Chaignon F, *Pavement Preservation: What About Energy and GHG*, Colas Group SA.

[4] For Pavement Preservation (FP^2), www.fp2.org.

One study conducted by Rutgers University[5] compared initial International Roughness Index (IRI), fuel consumption [6] and application year for pavement preservation implementation **(Figure 2)**. The results indicated that early pavement preservation can have a materially positive impact on CO_2e reductions.[7]

Figure 2 Pavement Preservation Impact on CO_2e Reduction



Source: Rutgers University

The implication for proactive early and recurring pavement preservation strategies clearly support significant GHG mitigation against multiple points of fossil fuel consumption directly related to our critical city infrastructure, including roadways.

Deterioration of Asphalt Pavements Due to Manufacturing and Environmental Factors

Asphalt pavements are vulnerable to many factors, thermal loading (excess heat) being the most damaging.[8] As noted, conventional paving materials can reach peak summertime temperatures exceeding 150°F.[9] And asphalt binder begins to photodegrade (oxidizes) at 120°F,[10] with exponential damage as the temperature rises.

Excessive heat required during manufacturing, typically 300°F to 350°F [11] or higher, is especially destructive, which leads to the volatilization or rapid loss of critical molecular components of asphalt binder that are responsible for durability and ductility (plasticity). These are commonly and scientifically referred to as **"maltene fractions"**.

[5] Wang H, Al-Saadi I, et al., Quantifying Greenhouse Gas Emission of Asphalt Pavement Preservation at Construction and Use Stages using Life-Cycle Assessment, *International Journal of Sustainable Transportation*, January 2019.
[6] EPA: Motor Vehicle Emission Simulator (MOVES) and other Mobile Source Emission Models, www.epa.gov.
[7] Wang H, Al-Saadi I, et al.
[8] Alkaissi ZA, Effect of High Temperature and Traffic Loading on Rutting Performance of Flexible Pavement, *Journal of King Saud University- Engineering Sciences*, April 2018.
[9] EPA Heat Island Reduction Program (HIRP): Using Cool Pavements to Reduce Heat Islands, www.epa.gov.
[10] Hossain K and Karakas AS, *Effect of Ultraviolet Aging on Rheological Properties of Asphalt Cement*, Memorial University of Newfoundland and University of Illinois, Urbana-Champaign, June 2018.
[11] Texas Asphalt Pavement Association, www.texasasphalt.org.

As much as a third of maltene molecular content may be lost during asphalt production,[12] leaving asphalts prematurely aged by the impaired binder.

Maltenes are the "media" that enable asphalt binder to impart flexibility, fluidity, and adhesion properties to paved roads. They are largely responsible for the resilience of asphalts to withstand considerable environmental and traffic stresses.

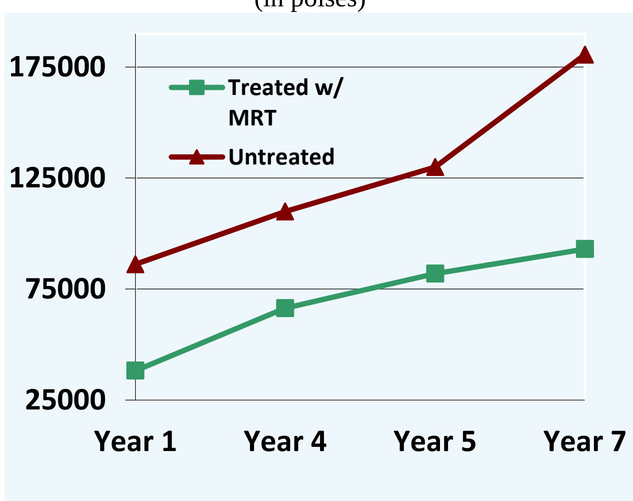
Asphalts with depleted binder chemistry become embrittled, leading to cracking and raveling stress and accelerated repair and rebuild demands.

In-service, heat continues its extortionate role in depleting maltene content in asphalt binder due to the oxidative effect of irradiation (UHI), as asphalts are highly solar energy absorptive.[13] In combination, volatilization and UHI stress are the primary factors responsible for binder-centric failure of asphalt pavements and premature rebuild needs.[14]

A proven remedy for restoring damaged or aged asphalt binder to proper performance properties is to **chemically replace** the maltenes lost during manufacturing and in-service weathering through maltene replacement therapy. MRT, effectively, establishes a molecular **"second curve"** to the LCAs of asphalt pavements.

Figure 3 Maltene Rejuvenator Study:
Seven Year Oxidation Rate Curves in Charleston County (SC) [15]

(in poises) [16]



Source: Pavement Technology, Inc.; APART

[12] U.S. Department of Transportation, Federal Highway Administration, Superpave Asphalt Mixture Design Workshop, Version 8.0, Updated January 2002 www.fhwa.dot.gov.
[13] EPA Heat Island Reduction Program (HIRP), *Cool Fixes for Hot Cities Part 2: Los Angeles*, September 2002.
[14] Lolly R, *Evaluation of Short Term Aging Effect of Hot Mix Asphalt Due to Elevated Temperatures and Extended Aging Time*, Arizona State University, May 2013.
[15] Reclamite® is a trademark of Ergon, Inc.
[16] The poise (symbol P) is the unit of dynamic viscosity (absolute viscosity) in the centimeter-gram-second system of units.

(Figure 3) is an abstract from a multi-year study on asphalt pavements in Charleston County (SC) treated with Reclamite®, a petroleum maltene-based rejuvenator.

The maltene rejuvenator not only was able to reduce the initial viscosity (improve resilience) of the pavement (by over 50%), it effectively **reset the oxidation curve** for the pavement over the following seven years, dramatically extending the LCA of the pavement.

MRT has been widely tested over the past half century with consistent excellent results. The method employs delivering an emulsified penetrating compound consisting of a near-pure maltene rich petroleum resin, a compatible surfactant, and water directly into the roadway surface.

The surfactant and water help deliver the fresh maltene fractions ratably and deeply into wearing-course depth. The result is a revitalized or "rejuvenated" asphalt binder which can be tested for measurably and sustainably improved rheology, as the Charleston data proves.

MRT has shown, with repeat treatments every three to five years, to extend the life cycle of asphalt pavements by two-fold and at a fraction of the cumulative cost of repaving, reducing reliance on petroleum feedstocks and cutting energy, maintenance and replacement costs.

MRT is the asphalt pavement preservation base found in PTI's **A.R.A.-1 Ti®**.

Combining a proven pavement LCA extending technology with a photocatalytic enhancement has shown great results and synergies beneficial to multiple level CO_2e reductions for pavement infrastructures.

Real Science. Real Results.

www.GetMaltenes.com