SCRAP TIRE RUBBER FOR ENERGY-EFFICIENT PAVEMENTS

A treatment process enhances the commercial viability of mixing ground, scrap tire rubber into asphalt.

Worn-out tires are an underused resource in the United States. Cars, buses, and trucks cast off 274 million tires in 2021. While more than two-thirds of these were recycled, that leaves nearly 80 million tires that never made it to a secondary market.[1]

Among the many uses for scrap tires, which include tire-derived fuel and mulch, asphalt holds untapped potential. When mixed into asphalt, ground tire rubber offers equivalent or better performance to asphalt modified with virgin styrene-butadiene-styrene (SBS) elastomers, but possibly at a lower cost. But even though ground rubber was the biggest secondary market for scrap tires in 2021, only 10% of that went into asphalt—a decline from previous years.[2]

Ground tire rubber has a higher density than asphalt, so it tends to settle to the bottom of storage tanks, so it cannot meet the storage stability requirements for asphalt. This inadequate storage stability makes ground tire rubber less preferable than SBS polymers as an asphalt modifier.

Researchers at Iowa State University (ISU) have developed a patented technique[3] to match the density of ground tire rubber with that of asphalt by compounding the rubber particles with scrap polydiene such as polybutadiene or polyisoprene. This process causes the particles to swell, decreasing their density and producing a modified ground tire rubber that meets current market storage stability specifications. ISU has partnered with Lehigh Technologies, a subsidiary of tire maker Michelin, to refine and demonstrate the technology.

PROJECT DESCRIPTION

This project will culminate in a paving demonstration of an asphalt modified with ground tire rubber that meets industry storage and performance requirements. First, a team of ISU engineers will lead the development of ground tire rubber and polymer formulations with the initial goal of identifying a minimum viable product that delivers the required storage stability. The team will investigate material variability, polymer identity, extrusion practices, ground tire rubber/polymer pellet characterization, and asphalt blending conditions. Lehigh Technologies will conduct independent verifications of the ISU lab-scale performance data.

Once a trial product has been identified, ISU and Lehigh will scale up production of the compound to a pilot scale of at least 2 tons. Feedstock and process variable sensitivity will be measured to develop initial specification ranges required for successful full-scale deployment of the technology.

The pilot product's storage stability and paving performance will be demonstrated in field trials in partnership with local and state agencies such as the Iowa Department of Transportation.

At the end of the project, ISU will conduct a life-cycle analysis to quantify the embodied energy savings and carbon dioxide

[1] U.S. Tire Manufacturers Association (USTMA). *2021 U.S. Scrap Tire Management Summary.* October 25, 2022. https://www.ustires.org/sites/default/files/21%20US%20Scrap%20Tire%20Management%20Report%20101722.pdf. Accessed February 21, 2023.

[2] USTMA.

[3] Williams, R. Chris; Cochran, Eric W.; Hernández, Nacú B. Patent Pending: "Ground Tire Rubber Density Modification Using Elastomeric Polymers."

PROJECT NUMBER: 18-02-MM-03

emissions reduction associated with using ground tire rubber as an asphalt modifier in place of SBS. The results of the paving trials will be documented to verify the performance of the asphalt modified with ground tire rubber.

PROJECT IMPACT

ISU's technology could enable not only increased use of ground tire rubber, but of scrap polydienes that are a byproduct of tire manufacturing. This could replace up to 100% of the SBS used in asphalt modification, which is currently 140,000 tons a year, and enable the use of 50,000 metric tons of scrap polybutadiene.

The ability to use reclaimed materials will create energy and emissions benefits because of the avoided need to produce SBS. Ground tire rubber in asphalt could save 4.2 petajoules per year of energy, the equivalent of more than 1,000 gigawatt hours, and avoid 140 ,000 metric tons of carbon dioxide emissions per year.

NEXT STEPS

The project has developed and confirmed a ground tire rubber formulation that meets the performance specifications as a modifier for asphalt. Lehigh Technologies has successfully scaled production of the formulation at pilot scale to produce 2 tons of material that will be used in a road paving trial to establish the performance of the modified asphalt.

PROJECT PARTNERS

IOWA STATE UNIVERSITY

Principal Investigator:
R. Christopher Williams | rwilliams@iastate.edu

Nacu Hernandez-Cantu

Eric W. Cochran

LEHIGH TECHNOLOGIES

A Michelin Group Company

Tom Rosenmeyer

PUBLICATIONS

Hallmark-Haack, B.L. *Understanding the Principles for Storage Stability in Ground Tire Rubber Modified Binder*. July 21, 2022. 59th Asphalt Research Conference, Laramie, WY.

Williams, R. Chris; Cochran, Eric W.; Hernández, Nacú B. Patent Pending: "Ground Tire Rubber Density Modification Using Elastomeric Polymers."

FOR MORE INFORMATION

EMAIL US AT CONTACT@REMADEINSTITUTE.ORG

OR VISIT US AT REMADEINSTITUTE.ORG

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Acknowledgment: "This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Advanced Manufacturing Office Award Number DE-EE0007897."