Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

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Inventors

Anca Delgado
Elham Fini
Sk Faisal Kabir

Contact

Shen Yan
shen.yan@skysonginnovations.com

Method and System for Microbial Desulfurization and Surface-Activation of Rubber

Background

Crumb tire rubber asphalt is a noise reducing pavement material that is made from asphalt concrete mixed with crumb rubber from recycled tires and is superior to current materials in terms of durability and service life. Tire disposal to landfills has substantially increased in recent years, but the usage of tire rubber in asphalt or similar applications has remained the same. Landfill-disposed or recycled rubber is mostly vulcanized, meaning the rubber polymer molecules are crosslinked with sulfur through an irreversible reaction.

Vulcanized rubber is chemically incompatible with asphalt binder and does not disperse well in asphalt. Additionally, because sulfur has linked polymers together in rubber, polymers are not available to fully impart their beneficial effects on asphalt or adequately interact with asphalt components. Because of this, crumb rubber in asphalt mainly works as elastic particulates. Crumb rubber asphalt requires continuous agitation before being applied, which increases the cost of the process and prevents the use of a higher percentage of crumb rubber in the asphalt formulation.

Microorganisms capable of breaking the crosslinked sulfur bonds on the surface of rubber are part of the natural microbiomes of soils, sediments, surface waters, and groundwater. These microorganisms typically couple the oxidation of sulfur with the reduction of oxygen to get energy for growth.

Invention Description

Researchers at Arizona State University have developed a novel system and method for producing microbially desulfurized rubber for use in asphalt applications. This invention uses the recently discovered ability of sulfur-oxidizing microorganisms (non-pathogenic bacteria) in a controlled bioreactor to break the cross-linked sulfur bonds in rubber polymers. The resulting microbially-desulfurized rubber has an enhanced interaction with asphalt and thus increases the performance of the final material.

Potential Applications

- Pavement construction
- Recycling of scrap tires to promote resource conservation

Benefits & Advantages

- Lower cost due to reduction in asphalt binder usage

- Higher percentage of rubber in the asphalt mixture
- Decreases segregation of the rubber and binder
- Requires less agitation of the rubber
- Facilitates mixture placement for contractors
- Requires lower mixing temperature (preserves functional polymers in rubber)

Related Publication: Use of microbially desulfurized rubber to produce sustainable rubberized bitumen - ScienceDirect