MARKET OPPORTUNITY SUMMARY

SOY PRODUCTS FOR RUBBER COMPOUNDS

USE SOY

SOY PRODUCTS PERFORM AS PROCESS AIDS AND REINFORCING FILLERS IN RUBBER COMPOUNDS WITH A SUSTAINABILITY ADVANTAGE.

Rubber Industry Overview

The rubber industry value chain is complex, with a number of large producers of elastomers; a range of large to small suppliers of rubber compound ingredients; and many compounders, fabricators and original equipment manufacturers using rubber. World consumption of rubber exceeds 25 million metric tons as of 2012.

Rubber Market Segments

- Pneumatic tire compounds
- Tire retreading
- Extruded rubber products
- Molded goods
- Power transmission belts
- Conveyor and flat-transmission belting
- Hoses
- Open-cell sponge rubber
- Rubber-covered rolls
- Footwear soles and heels
- Wire and cable
- Elastomeric seals
- Coated fabrics
- Roofing and liner membranes

Established Uses

- Vulcanized vegetable oil (including soy) as an extender and rubber substitute results in improved ozone resistance and improved flow properties.
- Epoxidized soy oil — plasticizer/stabilizer in plastics and rubber.

Tire Applications

Current developments can help the amount of petroleum-based oil used in tires while simultaneously extending tread life. Tests have shown that using soy oil in tires can potentially increase tread life by 10% while reducing the use of petroleum-based oil. Improved mixing capabilities in the manufacturing process have been demonstrated, and rubber compounds made with soy oil blend more easily with the silica used in building tires. This can improve plant efficiency and reduce energy consumption and greenhouse gas emissions.

Bridgestone created a new agricultural concept tire for large, four-wheel drive tractors with eight tires. Soy oil constitutes more than 10% of the 900-pound farm tire.

After years of testing, Goodyear Tire and Rubber Company announced in August 2017 the release of Assurance WeatherReady tires, featuring a unique soy-based tread with enhanced traction. Soybean oil replaces petroleum-based mineral oil as a plasticizer or extender in the polymer finishing stage of SSBR (solution styrene-butadiene rubber) polymer production. This enables the material to remain more flexible at lower temperatures than petroleum-based rubber compounds, improving traction in a variety of weather conditions. Rubber made with soybean oil also mixes more easily in

the silica-reinforced compound used in tire manufacturing. Goodyear says this makes the compound easier to process, which improves manufacturing plant efficiency and reduces energy consumption.

Technology

Most elastomers require processing aids and plasticizers to reduce the internal friction generated during mixing of the rubber compound. With lower internal friction, compounds incorporate fillers with less power consumption, a lesser tendency to scorch and an ability to process more smoothly. Rubber compounds often require reinforcing materials to improve their physical properties, and fillers can potentially reduce the net cost of a compound.

Current Research Status

Current and recently completed research projects include:

- Rubber uses for polymerized soy oil
- Modified soy hulls for rubber reinforcement
- Soy oil to replace petroleum oils in extended rubber
- Soy-based oil polymers in rubber compounds
- Soy-based rubber and rubber composites
- Soy-based rubber automotive seals
- Chemical bonding of free sulfur in soy-vulcanized compound
- Soy-based reactive materials for tires and elastomers
- Epoxidized soy oil in conjugated diene elastomers and tires
- Soy oils and polyols in high-performance elastomeric compounds

Driving Issues

Rubber and tire producers are replacing extender oils containing polycyclic aromatic components with environmentally friendly oils in response to sustainability strategic initiatives and the European Union directive banning high-aromatic oils. The primary oil used has traditionally been Distillate Aromatic Extracts (DAE), due to its solvency and ability to vulcanize rubber.

DAE, however, is suspected to have carcinogenic effects. Only oils with low levels of Polycyclic Aromatic Hydrocarbons (PAH) are allowed in tires manufactured in or imported into the EU, as of 2010.