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Modified soybean oil as a processing oil for SBR/BR rubber compounds

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The main goal of this research was to utilize soybean oil (SBO) for rubber compounds as a bio-based alternative for conventional petroleum-based processing oil (PPO). Direct replacement of SBO in styrene-butadiene (SBR) rubber compounds leads to degradation of rubber properties including tensile strength and moduli. It was found that proper modification of SBO with grafted polystyrene oligomer overcomes these deficiencies. The rubber compounded with modified SBO demonstrates properties comparable with those of rubber compounded with PPO.

SBO was modified with grafted polystyrene using radical graft polymerization.

Polystyrene-grafted SBO (SBO-PS) having 15, 20, 25 and 30 wt. %% of grafted polystyrene were synthesized. SBO-PS oils were used for silica-filled SBR-polybutadiene (BR) rubber compounds in amount of 33 phr. As a reference, a rubber with naphthenic oil (NO) was compounded. The rubbers were vulcanized and tested in tensile test, durometer hardness test and dynamic mechanical analysis (DMA). The curing profile for each rubber compound was studied in the curing rheometer test. The curing rheometer test demonstrated shorter curing window for all SBO-based rubbers, but the rubber compounded with SBO-PS30 oil showed a curing profile similar to the curing profile of the NO-based rubber.

All rubbers compounded with SBO-PS oils demonstrated higher tensile strength and elongation but similar or lower modulus than the rubber compounded with NO.

Durometer hardness test indicated slightly lower value for the hardness for all SBO-PS-based rubber compared to the NO-based rubber.

Based on DMA testing, using SBO-PS-contained rubber compound in the tire tread can lead to an improvement of both rolling resistance and wet traction, if compared to NO-based rubber.

Modification of SBO with grafted polystyrene is a promising way to replace a petroleum-based processing oil with a plant-based oil in SBR rubber compounds with an improvement in their properties.