

# Bio-Based Rubber Process Oils for Low Rolling Resistance Silica-Reinforced Natural Rubber Tire Tread Compounds

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**Abstract:** Towards more sustainable rubber industry, natural-based compounding ingredients should be utilized including natural rubber (NR) and bio-based process oil. This work investigates epoxidized palm oil (EPO) and its amine-modified form (mEPO) as alternatives for petroleum-based process oil in silica-reinforced NR tire tread compounds. The properties of such compounds are compared to that of reference mixes with treated distillate aromatic extract (TDAE) and without oil. When compared to the compound with TDAE, the one with EPO shows a lower viscosity, lower filler-filler interaction and flocculation rate constant, but higher cure reaction rate constant as a result of interactions between the epoxide groups in EPO with the silanol groups on the silica surface that promote hydrophobicity on the polar surface. By increasing epoxide contents in the range of 1-3 mol% in EPO, the cure reaction, tensile properties and loss tangent at 60°C are improved. The use of mEPO further enhances the vulcanization reaction due to an alkaline amino group in the mEPO oils, resulting in higher crosslink density and better mechanical properties as well as elastic response under dynamic conditions, compared to the mix with TDAE. The use of mEPO results in reduced loss tangent at 60°C, an indication for lower rolling resistance of tire tread made thereof. Therefore, the perspective of more “green and sustainable” tires is fulfilled.

**Keywords:** Natural rubber; silica; epoxidized palm oil; process oil