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Implications of non-carcinogenic pah-free extender oils in natural rubber based tire compounds

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Abstract

The oils are generally added in the rubber compounds to improve processing properties, low temperature properties, dispersion of fillers, and to reduce cost. The conventionally widely used oils in tire compounds are Distillate Aromatic Extract (DAE) oils, which contain a high concentration of Polycyclic Aromatic Hydrocarbons (PAHs). PAHs that can be released from tires by tire wear are harmful to health and environment, so safe process oils are needed to replace aromatic oil in tire compounds. This thesis comparatively studies the influences of PAH-free petroleum based extender oils, i.e. Treated Distillate Aromatic Extract (TDAE) and Mild Extracted Solvate (MES), versus the DAE oil on the properties of NR-based truck tire tread compounds and NR/SBR-based passenger tire tread compounds. Oil characterization data are analyzed, and the influence of the oils on the properties of unfilled compounds is also elucidated. The different chemical structures and compositions of DAE-, TDAE- and MES-oils that affect on their characteristics, have influences on their compatibility with rubbers and the properties of the corresponding rubber compounds. The theoretical predictions based on differences in solubility parameters (Δδ) and the experimental swelling study agree well in that MES is less compatible with NR and SBR compared with TDAE and DAE. The difference of cure characteristics, due to the presence of nitrogen-and sulfur-heterocyclic species in DAE oil, as observed in unfilled compounds, is diminished in the carbon black-filled compounds. The mechanical properties of both unfilled and carbon black filled compounds are little influenced by the change of oil types, but the properties are changed according to the oil loadings, basically due to the dilution effect. The different glass transition temperatures (Tg) of the oils affect the Tg's of the rubber vulcanizates and hence the viscoelastic-related properties, i.e. abrasion resistance, rebound resilience, heat build-up and loss tangent. The replacement of toxic DAE by safe TDAE and MES enhances the elastic response of the materials. Based on the processing properties of the uncured compounds and mechanical as well as dynamic properties of the vulcanizates, TDAE oil provides better overall properties as replacement for DAE oil than MES.

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