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Enhancement of the degradation of vulcanized natural rubber by natural fatty oils

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The overall use of natural rubber for a large number of applications is constantly on the rise and results in a growing volume of rubber waste. The cross-linked structure of rubber and the presence of stabilizers cause rubber recalcitrance to both chemical and biological degradation. Landfill disposal of rubber materials leads to wastage of valuable rubber causing many environmental problems. Reclaiming and reusing are major approaches to solve this problem worldwide.

The current study was focused on studying the degradation of vulcanized natural rubber using natural fatty oils which have the potential to be used as reclaiming agents. The process of degradation strongly suggests that rubbers are susceptible to attack by free radicals from peroxidizable organic compounds under an oxygen atmosphere. Hence the radicals produced from lipid hydroperoxides by lipid autoxidation of unsaturated fatty oils have the ability to promote degradation of rubber.

Commercial grade coconut oil, corn oil and sunflower oil were used during the present research to study the degradation of Vulcanized Natural Rubber (VNR). VNR samples (10.6 cm x 10.6 x 0.2 cm) were prepared and immersed in fatty oils (300.0 mL) separately for various time periods such as 3, 6, 9 weeks at room temperature under dark environment and for 6 weeks in the presence of sunlight. At the end of the each time period, testing of mechanical properties was done by BS ISO 37-2010, BS ISO 34-1:2010 and BS ISO 48:2010 methods. Further characterization of the samples was performed using Fourier Transformed Infrared-Attenuated Total Reflectance spectroscopy (FTIR-ATR) and Scanning Electron Microscopy (SEM).

Results revealed that mechanical properties of VNR decreased when samples were immersed in fatty oils for longer time periods. Also as the degree of unsaturation of fatty oil increases, the mechanical properties decreased dramatically. In addition, the presence of sunlight enhances the loss of mechanical properties. According to the present study, the loss of mechanical properties was higher when vulcanizates immersed in sunflower oil under sunlight. Scanning electron micrographs of surfaces of samples immersed in corn oil and sunflower oil for 6 weeks under sunlight revealed the samples were deteriorated.

According to the results of the current study, the degradation of VNR can be enhanced by immersing vulcanized natural rubber in fatty oils such as sunflower oil and corn oil which are rich in polyunsaturated fatty acids. Therefore a new system can be developed for reclaiming and safe disposal of products derived from vulcanized natural rubber with the use of highly unsaturated fatty oils.

Keywords: Lipid autoxidation, Rubber degradation, Vulcanized natural rubber