TITLE A STUDY OF VISCOELASTIC PROPERTIES OF FLY ASH/NATURAL RUBBER COMPOSITES

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ABSTRACT Fly ash (FA) as a by-product of power station plants consists of silicon dioxide (SiO_2) similar to precipitated silica. Typically, FA particles are spherical with smooth surfaces having significant influences on mechanical and properties of polymeric composites. According to previous work, only the mechanical properties of FA filled NR have been studied and compared with precipitated silica. Thus, in this research, further investigation in properties of FA filled NR is extended by focusing mainly on the viscoelastic properties. The results obtained reveal that the incorporation of FA in NR increases storage modulus (G") and bulk viscosity under both oscillatory and steady shear flows. Moreover, the higher the FA loading, the larger the magnitude of viscous response in the FA filled NR compounds. The explanation is proposed in terms of a ball-bearing effect of FA particles associated with a molecular degradation of the rubber matrix as induced by the complex substances formed via fatty acids in the non-rubber component of NR together with heavy metals in FA particles. Such complex substances are believed to catalyze the degradation process of rubber molecules leading to storage instability of the compounds. Such a degradation process could effectively be suppressed by the addition of an amine-based antioxidant (6-PPD). By the incorporation of silanes, namely, Si-69 (bis (3-triethoxysilylpropyl) tetrasulfide), Si-264 (3-thiocyanatopropyl triethoxy silane), and VTEO (vinyltriethoxysilane), the increase in G' of compounds is found mainly in the system with Si-69 silane. Also, the pre-surface treatment of milled FA particles is shown to be an appropriate technique for FA surface treatment. With various curing systems, the cure reversion phenomenon is observed in the sulfur system with increased FA loading. On the other hand, the peroxide curing system exhibits the marching phenomenon, particularly at high FA loading greater than 150 phr. Additionally, the NR vulcanizates filled with FA in all curing systems show progressive decrease in tensile strength with increased FA loading, due to poor filler-rubber interactions. By treating FA surfaces with silanes, a marginal improvement in mechanical properties of NR/FA composites is observed in all curing systems with Si-69 silane due to the free sulfur released from the Si-69 during the

curing process. On the contrary, insignificant changes in mechanical properties with other silanes are attributed to the small amount of active silanol groups on FA surfaces.