Storage Instability of Fly Ash Filled Natural Rubber Compounds

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Abstract:
Generally, fly ashes (FA) could function as either semi-reinforcing or non-reinforcing fillers in polymeric systems, depending on particle size, specific surface areas and surface chemistry of FA particles. Typically, FA particles are spherical with smooth surfaces having significant influences on viscoelastic and mechanical properties. Additionally, the presence of heavy metals in FA particles could play role on degradation process of rubber molecules to some extent. In this article, the storage instability and thermal aging properties of FA filled natural rubber (NR) compounds were focused via changes in viscoelastic responses. Results obtained reveal that the storage duration of FA filled NR compounds leads to decreases in elastic modulus and molecular weight, particularly in the compounds with high FA loading. By replacing NR with polyisoprene (IR) containing no non-rubber substances, the storage stability is significantly enhanced. It is believed that the presence of metal ions in both FA and non-rubber substances in NR could catalyze the degradation process of rubber molecules. Such degradation process could effectively be suppressed by the addition of amine-based antioxidant.

Zusammenfassung:
Fliegenasche (FA) kann in Abhängigkeit von der Partikelgröße, dem spezifischen Oberflächeninhalt und der Oberflächenchemie der FA-Partikel als semi-verstärkender oder nichtverstärkender Füllstoff in polymeren Systemen wirken. Typischerweise sind FA-Partikel kugelförmig mit einer glatten Oberfläche, die einen signifikanten Einfluss auf die viskoelastischen und mechanischen Eigenschaften haben. Zusätzlich können Schwermetalle in FA-Partikeln zu einem gewissen Ausmaß eine Rolle bei der Zersetzung von Gummimolekülen spielen. In diesem Artikel wird die Speicherinstabilität und die thermischen Alterungseigenschaften von mit FA gefüllten Naturkautschuk (NR)-Kompositen hinsichtlich ihrer rheologischen Eigenschaften untersucht. Die Ergebnisse zeigen, dass die Speicherdauer von mit FA gefüllten NR-Kompositen zu einer Abnahme des elastischen Moduls und des Molekulargewichts führt, insbesondere bei den Kompositen mit einem hohen FA-Gehalt. Durch das Ersetzen von NR mit Polyisopren (IR), das keine Nichtgummimaterialien enthält, wird die Speicherstabilität deutlich erhöht. Es wird davon ausgegangen, dass die Metallionen sowohl in der FA und in den Nichtgummisubstanzen im NR den Zersetzungsprozess der Kautschukmoleküle katalysieren. Dieser Zersetzungsprozess kann durch die Zugabe von Amin-basierenden Antioxidantien unterdrückt werden.

Résumé:
En général, les cendres volantes (FA) pourraient fonctionner comme des charges semi-renforcissant ou non renforcissant pour les systèmes de polymères, suivant la taille de la particule, des surfaces spécifiques, et de la chimie de la surface des particules de FA. Typiquement, les particules de FA sont sphériques avec des surfaces lisses et ayant des influences importantes sur les propriétés mécaniques et viscoélastiques. De plus, la présence de métaux lourds dans les particules de FA pourrait, jusqu'à un certain degré, jouer un rôle dans le processus de dégradation des molécules de caoutchouc. Dans cet article, nous nous concentrons sur l'instabilité durant le stockage et sur les propriétés de vieillissement thermique de caoutchouc naturel (NR) chargé de FA, en étudiant les changements dans les réponses viscoélastiques. Les résultats obtenus révèlent que la durée de stockage des NR chargés de FA entraîne une perte de module élastique et de masse moléculaire, particulièrement pour les composés contenant de grandes quantités de charge. En remplaçant le NR par du polyisoprène (PI) ne contenant pas de substances caoutchouteuses, la stabilité durant le stockage est améliorée de manière significative.

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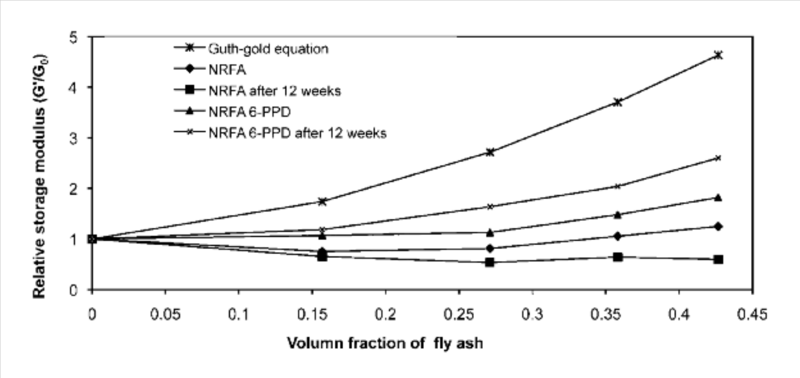

Figure 13:
Relative storage modulus (relative G_o) at 1 % strain of FA/NR compounds with and without 6-PPD before and after storage of 12 weeks.

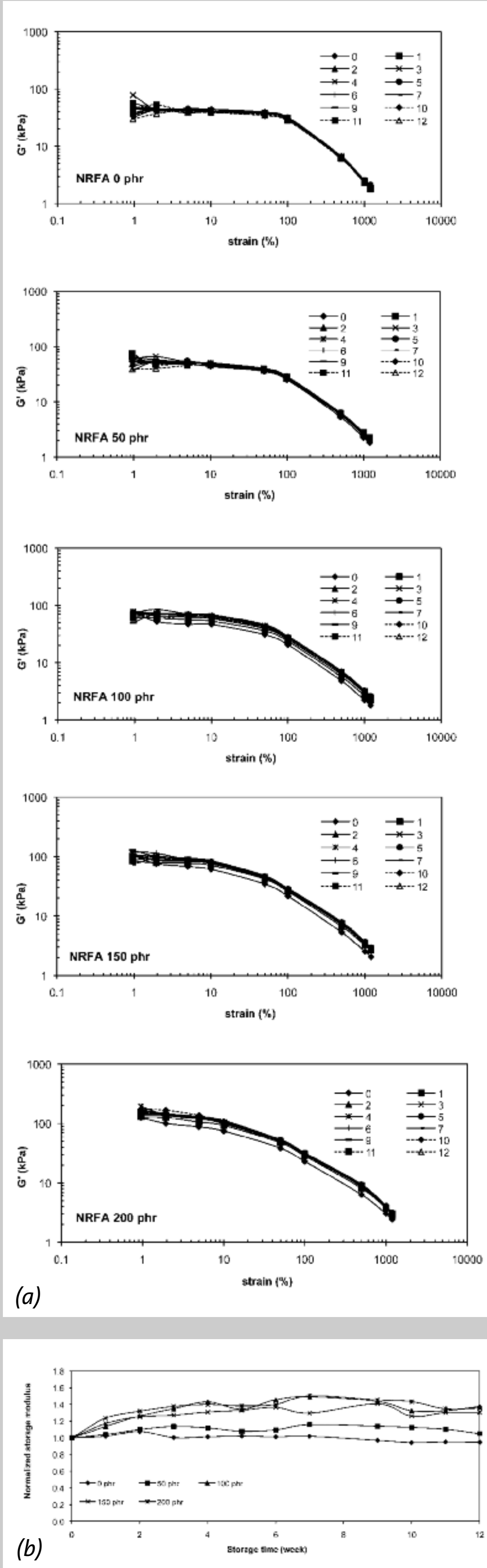

Figure 12 (right):
Effect of storage time on modulus of FA filled NR compounds stabilized with 6-PPD antioxidant: (a) storage modulus G' and (b) retention of G'.

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