Natural rubber to filler interaction study by determining creep rupture strength

By

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"I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any University and to the best of my knowledge and belief it does not contain any material previously published, written or orally communicated by another person except where due reference is made in the text".

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Abstract

Creep rupture of clay-rubber composites was studied by 180° peel test of flexible to rigid joints to evaluate the rubber-filler interaction. Static load providing separation of specimen at equilibrium peel rate, corresponding to 10^{-8} m/sec, the rate at which a kinetic segment of a hydrocarbon chain moves in an elementary event of thermal motion, was treated as peel strength of a specimen at creep rupture.

A methodology was developed to measure the peel strength at creep rupture in an open air and liquid medium active towards the interface of joined materials. Series of monohydric alcohols was selected since lower alcohols are strongly hydrogen bonded solvents whilst higher alcohols tend to strong dispersion interaction. The change in peel strength values due to variation of solubility parameter of the selected alcohols was used for identification of molecular bonds established across rubber filler interface.

Decreasing in the peel strength values with increasing in despersive component of the solubility parameter of the hostile medium indicated the presence of dispersion bonds across rubber-filler interface. Hydrogen and polar bonds were identified by decreasing the peel strength values due to increasing polar component of the solubility parameter of the alcohols to which a specimen was exposed, while stability of joints to action of hostile medium, proved the presence of chemical bonds established across the rubber - filler interface.

Obtained peel-strength values correlated well with bound rubber content, ensuring that the results have realistically characterized rubber-filler interaction. The chemical nature of the filler surface was the main factor influencing it, that has made possible in commercial practicability the modification of the inert filler in order to enhance its effect on rubber properties.

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Contents

List of Tables

List of Figures

Nomenclature

A	- Physical creep rates
B	- Chemical creep rates
χ_o	- initial deflection
χ_1	. deflection at time t
C	- volume fraction of the solid spheres
δ_a	- associative component of solubility parameter
δ_d	- dispersive component of solubility parameter
δ_e	- mean cohesion or aggregation energy per particle between the particles in the original aggregate
D	- uniform diameter
d	- ultimate particle diameter
E	- Young's modulus of the rubber
F	- total energy of immersion per unit surface area of the filler in rubber
FF	- fine furnace
HAF	- high abrasion furnace
MT	- medium thermal
M	- moduli of elasticity of the filled polymer
Mo	- moduli of elasticity of the unfilled polymer
N	- number of filler particles
n	- number of measurements
PVA	- Poly Vinyl Alcohol
ρ_f	- functional heat term
ρ	- density
RSS	- Ribbed Smoked Sheet
SAF	- super abrasion furnace black
SRF	- semi-reinforcing furnace
t_o	. initial time
t	- time
V	- volume