

Performance of coconut kernel residue oil as a processing oil in carbon black filled natural rubber composites

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Introduction

Processing oil is aromatic or aliphatic hydrocarbon used in dry rubber compounding to obtain efficient dispersion of filler in rubber, lower the power consumption during mixing, provides lubrication between rubber molecules. Incorporation of processing oil improves the physical properties of natural and synthetic rubber such as elasticity, low temperature performance, and aid in the dispersion of pigments resulting in improvement of tensile strength and abrasion resistance and rather they decrease hardness, elongation at break, tensile strength, resilience. Mainly aromatic, paraffinic and naphthenic oils are used as processing oils in dry rubber compounding. According to the regulations of European Parliament, use of petroleum based processing oil rich in polycyclic aromatic hydrocarbon has been banded since 2009 due to carcinogenic. Therefore, scientists are switching onto naturally occurring oils because of restriction on use of fossil fuel based processing oils. An effort was taken to evaluate the performance of the Coconut Kernel Residue Oil (CKRO) as a processing oil in Carbon Black (CB) filled natural rubber composites.

Methodology

Firstly, the CKRO was characterized with regards to free fatty acid, moisture, ash and metal ions content (Fe^{+2} , Cu^{+2}). Then CKRO was incorporated in different treatment levels (0, 2, 4, 6, 8 and 10 phr) as processing oil in carbon black (CB) filled natural rubber composites. Both curing and physico-mechanical properties including tensile strength, tear strength, elongation at break, abrasion volume loss, compression set, rebound resilience and harness of the vulcanizates containing different levels of CKRO were compared against the standard vulcanisate which was prepared by using 6 phr of aromatic oil used in the industry at present and all the tests were carried out according to the ISO standard test methods.

Table 01: Treatment Combinations

Treatment	T _c	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
CKRO(phr)	-	0	2	4	6	8	10
Aromatic Oil phr	6	-	-	-	-	-	-

Result and Discussion

Table 02: Characterization of the CKRO

Parameter	Free Fatty Acid (%)	Moisture (%)	Content	Metal (ppm)	Ions
				Ion	Copper
CKRO	7.2	4.14		1.715	0.04

There is a high amount of free fatty acid content in coconut kernel residue oil, because it has become more rancid with time.

Table 03: Curing Characteristics of Rubber Composites

Oil phr	MH	ML	Tc90	Ts2	CRI
6a (control)	26.59	4.53	9.96	3.37	15.17451
0	27.62	3.82	10.12	3.02	14.08451
2	27.06	4.95	10.35	3.57	14.74926
4	25.64	3.94	10.45	3.67	14.74926
6	25.85	3.83	10.27	3.44	14.64129
8	22.7	3.29	10.5	3.82	14.97006
10	21	2.73	10.45	3.88	15.2207

Results of the present study revealed that, there is a reversion trend in maximum and minimum toque with the increasing of oil phr levels the in compounds. Minimum and maximum toques of the compounds contain 2, 4, and 6 phr of oil are comparable those of the reference. T s2, Tc90 and CRI are increasing with the increasing of CKRO phr.

Furthermore, it was found that, oil phr doesn't make any influence on tensile strength, tear strength and the hardness of the compounds whereas the aging properties are better for all compounds due to formula has conventional vulcanizations system. Moduli of the compounds contain 2, 4, 6, 8, and 10 are comparable with reference whilst the elongation is correspondingly increases with oil phr. There is decreasing trend in abrasion volume loss with the increasing of oil phr and 8 and 10 phr showed the lowest abrasion volume loss. Compression set of the rubber composite contain 6 phr of oil is comparable with the reference. Rebound resilience of the compounds contain 2, and 6 are comparable with the reference while 10 phr shows the minimum rebound resilience.

Conclusions

The lowest toque and the maximum toque were decreasing with the increasing processing oil content. Scorch time, cure time and cure rate index were increasing with the increasing of oil phr. Furthermore, there were no significant differences among the oil contents on tensile strength, tear strength and hardness of the compounds within the studied range. Even though, the compression set of all the compounds were not in an acceptable level due to the presence of more free fatty acids. Moduli, tensile stain at break, abrasion volume loss and rebound resilience could be optimized by using coconut kernel residue oil as a processing oil for the tyre tread compound formulation instead of using banded carcinogenic aromatic processing oil.

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