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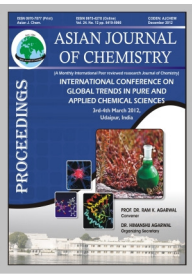

Comparison of HPCA Oil Tyre Tread Cap Compound with Low Polycyclic Aromatic Oil†

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Eco-friendly tires really live up to their name according to the independent tire retail giant, it depends on the tire. Most green tires claim to increase fuel mileage, helping to decrease a consumer's carbon footprint. As fuel economy regulations tighten and consumer demand for green transportation increases, tire manufacturers worldwide are adding precipitated silica to tread formulations to improve fuel efficiency, eliminate greenhouse gas emissions and enhance tire performance and handling. Reducing rolling resistance, or the amount of energy spent to move a vehicle, is an increasingly important solution to decreasing fuel consumption. In fact, tires are responsible for 20 to 30 % of a vehicle's fuel use. Rheology is principally concerned with extending the classical disciplines of elasticity and newtonian fluid mechanics to materials whose mechanical behaviour cannot be described with the classical theories. It is also concerned with establishing predictions for mechanical behaviour based on the micro- or nanostructure of the material, *e.g.* the molecular size and architecture of polymers in solution or the particle size distribution in a solid suspension. Materials flow when subjected to a stress that is a force per area. There are different sorts of stress (*e.g.* shear, torsional, *etc.*) and materials can respond in various ways. Thus much of theoretical rheology is concerned with the forces associated and external applied loads and stresses and the resulting internal strains. The object of this study was to investigate the MIN TQ. (lb-in), MAX TQ. (lb-in), Final TQ. (Ilb-in) of a tyre tread cap compound.

Key Words: Low PCA oils, Polycyclic aromatics, Carcinogenesis, PAH.

INTRODUCTION

The rheological behaviour of the sample was studied using a parallel plate rheometer and the rheological material functions. In the present work three types of low poly cyclic aromatic and one regular high poly cyclic aromatic petroleum oils were rheologicaly analyzed. These low polycyclic aromatic oils can act as the best alternative processing aids for rubber industry. The rheological, properties of SSBR loaded with different low poly cyclic aromatic and HPCA oils have been studied. Rubber formulations used in various tyre components previously have been designed using conventional processing oils. However, in changing to the use of the lower polycyclic aromatic content oils, some lose in rubber compound performance is noted. It is, therefore for necessary to develop new rubber compounds that provide desirable performance levels in corporating the use of low polycyclic aromatic oils[1-4].

EXPERIMENTAL

Mixing of rubber compound was carried out using a two-wing rotor laboratory Banbury mixer (Stewart Bolling, USA) in three stages (master batch remill and final batch) and the formulations are given in Table-1.

Master batch mixing was done setting the temperature control unit (TCU) at 90 ºC and rotor speed at 60 rpm. After the power integrator (PI) indicated achievement of 0.32 kWh, the master batch was dumped. The dump temperature of the master batches was found to be within 140-150 ºC. The master batches were sheeted out in a laboratory two-roll mill. Further mixing of the master batches were carried out after a period of 8 h. For final batch mixing, the temperature control unit was kept at 60 ºC and rotor speed at 30 rpm. The earlier prepared master batch was mixed with sulfur, accelerator and scorch inhibitor. The batch was dumped at a power integrator reading of 0.12 kWh[5-11].

Materials studied are given in Table-1.

RESULTS AND DISCUSSION

The global market place is increasingly demanding safe process oils to reduce the environmental impact of tires. The replacement of classified distillate aromatic extracts by non-carcinogenic MES, TDAE, or naphthenic process oils will

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reduce the PAH emissions. The data (Tables 2 and 3) show that the best results are obtained using low polycyclic aromatic hydrocarbons. A comparative study has been carried out on SSBR filled with various oils.

TABLE-1

Ingredients	TCR	LPCA-1	LPCA-2	LPCA-3
RMA4	27	27	27	27
BR	35	35	35	35
VSL 5525	52	-	-	-
Tufden 3835	-	52	52	52
N339	60	60	60	60
Reg Ar. Oil	5	-	-	-
LPCA Oil-1	-	5	-	-
LPCA Oil-2	-	-	5	-
LPCA Oil-3	-	-	-	5
ZnO(WS)	2.25	2.25	2.25	2.25
St Acid	0.5	0.5	0.5	0.5
6PPD	1.9	1.9	1.9	1.9
MC wax	2.4	2.4	2.4	2.4
MS 40	1	1	1	1
S(108)	2.2	2.2	2.2	2.2
TBBS	1.2	1.2	1.2	1.2
DCBS	0.6	0.6	0.6	0.6
PVI	0.15	0.15	0.15	0.15
Batch weight	191.2	191.2	191.2	191.2

LPCA-Low poly cyclic aromatic

TABLE-2

Ingredients	TCR	LPCA-1	LPCA-2	LPCA-3
RHEOMETRIC PROPERTIES @ 160 ^{0}C/30min (final)				
MIN TQ. (lb-in)	2.45	2.61	2.47	2.64
MAX.TQ. (lb-in)	15.84	15.36	15.68	15.75
Final TQ. (Ilb-in)	14.56	14.19	14.41	14.32
tS1 (min)	4.1	4.63	4.42	4.57
tS2 (min)	5.07	5.6	5.26	5.6
tC10 (min)	4.59	5.05	4.82	5.03
tC40 (min)	5.69	6.29	5.95	6.31
tC50 (min)	5.87	6.51	6.18	6.51
tC90 (min)	7.79	8.7	8.4	8.42
Max-Min Tq. (lb-in)	13.39	12.75	13.21	13.11

TABLE-3

Ingredients	TCR	LPCA-1	LPCA-2	LPCA-3
RHEOMETRIC PROPERTIES @ 193^{0}C/2.5min				
MIN TQ. (lb-in)	0.23	0.23	0.23	0.23
MAX.TQ.(lb-in)	1.99	1.86	1.95	1.88
Final TQIlb-in)	13.61	13.02	13.02	13.21
tS1 (min)	0.49	0.5	0.5	0.5
tS2 (min)	0.66	0.67	0.65	0.65
tC10 (min)	0.5	0.52	0.52	0.52
tC40 (min)	0.83	0.84	0.84	0.83
tC50 (min)	0.88	0.89	0.89	0.87
tC90 (min)	1.19	1.19	1.21	1.18

TCR- Tread compound regular; LPCA-Low poly cyclic aromatic

Conclusion

Test results are intended to support the rubber and tire industries in their environmental challenge to replace the classified aromatic oils. Further extensive compounding and evaluation work will be required by each company using its proprietary tire formulation technology. Demand for these oils is expected to rise as car manufacturers realise that carcinogenic emissions from tires can here by be greatly reduced. It has demonstrated on a commercial scale that this challenge can be met by a change to safer alternatives such as low poly cyclic aromatic. The production of low polycyclic aromatic oil are already on the market.

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