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IMPROVING THE MECHANICAL PROPERTIES OF THE RUBBER COMPOUND OF THE VEHICLES' TIRES: A LITERATURE OVERVIEW

People are shifting from use of fossil fuel based processing oils to naturally occurring oils, and restriction on PCA rich extender oils by December 2009 leads to search for naturally occurring oils. According to the KEMI report, products with polycyclic aromatic compounds, PCAs, levels exceeding 3 % by weight must be labeled. The report pointed out that worn tyre tread material was being spread on the roadsides, introducing high amounts of PCA into the environment. PCA is having toxic effects on aquatic organisms. For the sidewall tyre rubber, the way to improve the properties is a stepwise downsizing method of gel particles in reclaimed rubber to a micro-nano scale and its excellent dynamic performance in tire sidewall were introduced by this work.

In the present work, two naturally occurring oils, neem oil and kurunj oil, were characterised in a 100 % Natural Rubber based formulation, a NR/BR blend based Bias Truck and Rib Type Tyre Tread Cap compound and a SSBR/NR/BR blend based Radial Passenger Tyre Tread compound.

Compounds made with naturally occurring oils showed better abrasion properties. These oils were found to be suitable also on the basis of low PCA content. The results for the tyre sidewall showed that the size of gel particles decreased from several micrometers to micro-nanometers with the increase of reclaiming degree, accompanied by reduced molecular weight and widened molecular weight distribution of sol fraction. The addition of reclaimed rubber with low Mooney viscosity improved the dynamic mechanical properties of the natural rubber/butadiene rubber blends effectively, including wet resistance and rolling resistance. Moreover, the flexing fatigue resistance has also been improved dozens of times compared to traditional tire sidewall.

Keywords: tyre thread rubber, tyre sidewall rubber, nanostructured polymers, non-polymeric materials and composites, rubber.

Introduction

Rubber is a fantastic material and is widely used in our normal lives due to its special characteristic: visco-elasticity. Use of a single rubber is rarely adequate for manufacturing of rubber products. Therefore, blends of rubbers are achieving more and more technological and commercial interest since they provide an acceptable technological process for accessing properties not available in a single elastomer.

The tyre sidewall is the outer surface of the tyre between the bead and the tread, as shown in figure 1. It provides a physical link between the wheel and the tyre tread in transmitting power and braking forces to the tyre tread. The tyre sidewall also plays a significant role in a vehicle's suspension and in the general handling of the vehicle on the road. As it undergoes distortion from the load bearing down on the tyre, one of the most significant properties of the sidewall is its flexibility [1].

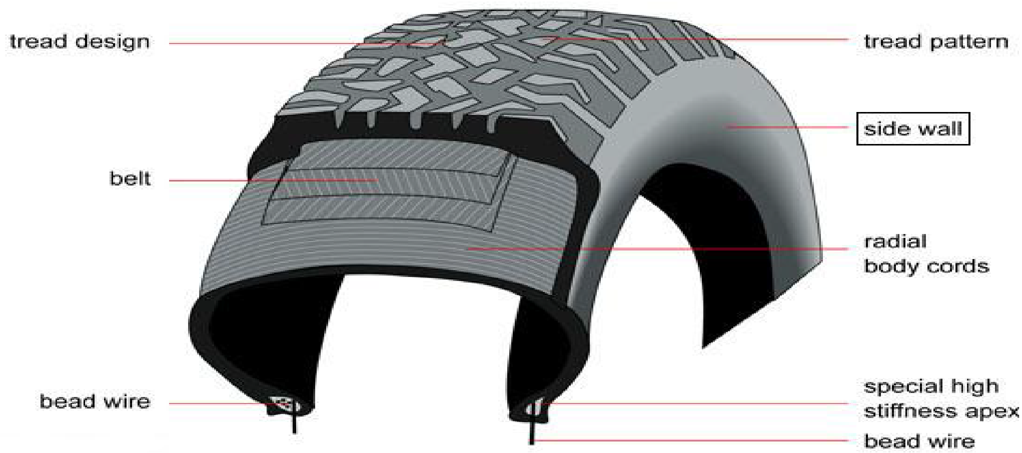

Figure 1 – Various components of a radial tyre are shown in this cutaway view

The potentially improved properties include chemical, physical and processing benefits. Changing intramolecular composition, such as making block copolymers, is a way to achieve tunable properties as well. However, this is limited by available synthesis processes. Intermolecular changes, such as adjusting composition or distribution of components in blends, are not limited by such synthetic limitations and are commercially preferred.

Today the use of rubber blends is more widespreaded in applications, including belts, hoses, footwear and especially tyres and tyre related products. A tyre is an assembly of a series of parts, each of which has a specific function in the service and performance of the product. Table 1 lists the important components of tyres and the typical blends used for them [2].

Table 1 – Rubber Blends in Automotive Tyres [3]

Component	Passenger tyres	Truck tyres
Tread	SBR-BR	NR-BR or SBR-BR
Belt	NR	NR
Carcass	NR-SBR-BR	NR-BR
Black sidewall	NR-SBR or NR-BR	NR-BR
Inner liner	NR-SBR-IIR	NR-IIR

Natural rubber (NR) is known to exhibit numerous outstanding properties, such as good oil resistance, low gas permeability, improved wet grip and rolling resistance, coupled with high strength; having properties resembling those of synthetic rubbers.

Natural rubber coming from latex is mostly polymerized isoprene with a small percentage of impurities in it.

This will limit the range of properties available to it, although addition of sulfur and vulcanization is used to improve the mechanical and physical properties. Chemically, natural rubber is cis–1, 4-polyisoprene and occurs in Hevea rubber trees [4, 5].

The use of carbon black is synonymous with the history of tires. However, the primary properties of carbon blacks are normally controlled by particle size, surface area, structure and surface activity which in most cases are interrelated [6].

The idea of blending synthetic rubbers with natural rubber is certainly not a new one, but now it can be applied positively, by using new techniques developed over the last 5 years. These compounds are capable of forming a chemical link between these dissimilar rubbers to produce a technologically compatible blend. The blend vulcanizates produced exhibit enhanced physical properties by judicious selection of the SBR: NR ratio [7, 8]. Blending of (SBR) and other types of rubber and its performance have been studied earlier, they have demonstrated that the physical properties of such blends can be significantly improved by adding a suitable compatibiliser [9–12].

This article presents an overview of some best way to improve the mechanical properties of the rubber sidewall of the vehicles that are ensure high reliability and low cost.

Materials and methods

Methods to Improve Thread Tire Rubber. Various methods have been developed by researchers to improve the mechanical.

Properties of the sidewall rubber. One of which was done, According to the KEMI report, products with polycyclic aromatic compounds, PCAs, levels exceeding 3 % by weight must be labeled. The report pointed out that worn tyre tread material was being spread on the roadsides, introducing high amounts of PCA into the environment. PCA is having toxic effects on aquatic organisms. In the present work, two naturally occurring oils, neem oil and kurunj oil, were characterised in a 100 % Natural Rubber based formulation, a NR/BR blend based Bias Truck and Rib Type Tyre Tread Cap compound and a SSBR/NR/BR blend based Radial Passenger Tyre Tread compound. Compounds made with naturally occurring oils showed better abrasion properties. These oils were found to be suitable also on the basis of low PCA content [11].

Results and discussion

1. Compound characterization in 100% NR based formulation.

1.1. Mooney viscosity, stress relaxation and Mooney scorch.

The Mooney viscosity, stress relaxation and Mooney scorch results are shown in Table 2. All three compounds showed comparable Mooney viscosity and stress relaxation for both the master and final batches. The compound mixed with NO_1 oil showed lower Mooney scorch.

Table 2 – Mooney viscosity, Mooney scorch and stress relaxation properties

Sample Id.	Mooney viscosity (master batch) MU	Mooney viscosity (final batch) MU	Stress relaxation (master batch) % drop	Stress relaxation (final batch) % drop	Mooney scorch min
100% NR based compound					
Aromatic oil	73.4	58.9	75.3	80.2	9.37
NO_1	72.4	60.3	74.8	78.8	8.88
NO_2	74.1	59.4	74.1	79.9	9.38
NR/BR blend based Bias Truck Tyre Tread Cap compound					
Aromatic oil	75.9	60.5	72.1	76.7	10.75
NO_1	77.9	62.8	71.1	75.0	10.50
NO_2	79.8	63.0	69.9	74.4	11.50
NR/BR blend based Rib Type Tyre Tread Cap compound					
Aromatic oil	64.7	57.6	77.3	79.8	18.81
NO_1	70.6	62.1	73.4	75.8	20.55
NO_2	69.4	60.6	73.3	76.3	22.53
SSBR/NR/BR blend based Radial Passenger Tyre Tread compound					
Aromatic oil	60.5	53.7	86.8	87.8	13.36
NO_1	59.0	51.7	85.5	87.1	12.23
NO_2	58.8	51.5	85.5	86.4	11.98

1.2. Flow behavior (frequency sweep).

The power law index results for master and final batches are shown in Table 3. All three compounds showed comparable flow behavior properties for both the master batch and final batch.

Table 3 – Power law index properties

Sample Id.	Test parameter	
	Power law index (master batch)	Power law index (final batch)
100% NR based compound		
Aromatic oil	0.203	0.227
NO_1	0.202	0.223
NO_2	0.202	0.229
NR/BR blend based Bias Truck Tyre Tread Cap compound		
Aromatic oil	0.168	0.189
NO_1	0.166	0.182
NO_2	0.165	0.182
NR/BR blend based Rib Type Tyre Tread Cap compound		
Aromatic oil	0.181	0.190
NO_1	0.166	0.179
NO_2	0.169	0.181
SSBR/NR/BR blend based Radial Passenger Tyre Tread compound		
Aromatic oil	0.278	0.292
NO_1	0.273	0.291
NO_2	0.264	0.282

1.3. Filler dispersion study.

The results for filler dispersion study of master and final batches are shown in Table 4. In both the master and final batches, compounds mixed with natural oils showed better filler dispersion.

Table 4 – Filler dispersion study

Compound Id.	parameter					
	Master compound)			Final compound		
	G0 (kPa) at 1% strain	G0 (kPa) at plateau level	Fraction recovery of G0 (G0 at plateau/G0 nitial)	G0 (kPa) at 1 % strain	G0 (kPa) at plateau level	Fraction recovery of G0 (G0 at plateau/ G0 initial)
100% NR based compound						
Aromatic oil	0.665	0.646	0.971	0.536	0.528	0.985
NO_1	0.626	0.625	0.998	0.533	0.532	0.998
NO_2	0.623	0.622	0.998	0.525	0.524	0.998
NR/BR blend based Bias Truck Tyre Tread Cap compound						
Aromatic oil	1.524	1.320	0.866	1.204	1.035	0.860
NO_1	1.768	1.504	0.851	1.073	0.973	0.907
NO_2	1.184	1.042	0.880	1.183	0.010	0.854
NR/BR blend based Rib Type Tyre Tread Cap compound						
Aromatic oil	1.262	0.990	0.784	1.200	0.939	0.783
NO_1	1.313	1.071	0.816	1.187	1.005	0.847
NO_2	1.254	1.040	0.829	1.126	0.926	0.822
SSBR/NR/BR blend based Radial Passenger Tyre Tread compound						
Aromatic oil	0.990	0.797	0.805	0.888	0.727	0.819
NO_1	1.026	0.905	0.882	0.885	0.734	0.829
NO_2	0.941	0.796	0.846	0.871	0.714	0.820

1.4. Polymer–filler and filler–filler interaction study.

The results for polymer–filler interaction study are shown in Table 5 for the master and final batches. In both the master and final batches, compound mixed with NO_1 oil showed marginally poorer, whilst compound mixed with NO_2 oil showed better, polymer–filler interaction.

Table 5 – Polymer–filler interaction study

Compound Id.	Parameter					
	Master compound)			Final compound		
	G0 (kPa) at 1% strain	G0 (kPa) at 25% strain	Payne effect	G0 (kPa) at 1% strain	G0 (kPa) at 25% strain	Payne effect
100% NR based compound						
Aromatic oil	218.6	118.6	100.0	163.9	91.7	72.2
NO_1	224.1	120.5	103.6	169.4	94.5	74.9
NO_2	213.1	121.4	91.7	153.0	90.0	63.0
NR/BR blend based Bias Truck Tyre Tread Cap compound						
Aromatic oil	333.34	145.10	188.24	267.77	113.69	154.08
NO_1	366.13	156.00	210.13	289.63	121.60	168.03
NO_2	355.20	156.86	198.34	267.77	119.46	148.31
NR/BR blend based Rib Type Tyre Tread Cap compound						
Aromatic oil	535.54	121.38	414.16	486.35	110.70	375.65
NO_1	513.68	147.03	366.65	475.43	126.51	348.92
NO_2	502.75	148.10	354.65	437.17	125.02	312.15
SSBR/NR/BR blend based Radial Passenger Tyre Tread compound						
Aromatic oil	306.02	88.05	217.97	245.91	69.24	176.67
NO_1	295.09	84.63	210.46	240.45	70.74	169.71
NO_2	295.09	86.98	208.11	234.98	70.09	164.89

1.5. Rheometric properties.

The rheometric results are shown in Table 6. Compound mixed with NO_1 oil showed faster cure characteristics, which was further confirmed by lower Mooney scorch value.

Table 6 – Rheometric properties

Sample Id.	Minimum torque (dN-m)	Maximum torque (dN-m)	ts2 (min)	Tc40 (min)	Tc50 (min)	Tc90 (min)
100% NR based compound						
Aromatic oil	2.27	14.93	6.93	8.44	9.31	16.44
NO_1	2.28	14.29	6.48	7.88	8.74	15.78
NO_2	2.24	14.34	6.86	8.28	9.12	16.27
NR/BR blend based Bias Truck Tyre Tread Cap compound						
Aromatic oil	2.97	15.81	8.58	10.98	12.28	23.17
NO_1	3.08	15.46	8.41	10.86	12.20	23.19
NO_2	3.06	14.82	9.28	11.43	12.67	22.81
NR/BR blend based Rib Type Tyre Tread Cap compound						
Aromatic oil	3.22	15.84	20.75	24.14	25.33	35.13
NO_1	3.46	15.38	18.19	20.78	21.96	32.39
NO_2	3.46	14.39	20.81	23.14	24.21	33.19
SSBR/NR/BR blend based Radial Passenger Tyre Tread compound						

Aromatic oil	2.08	19.76	3.63	4.22	4.38	6.29
NO_1	2.05	18.64	3.42	4.06	4.29	6.71
NO_2	2.09	18.19	3.30	3.80	3.96	5.77

2. Compound characterisation in NR/BR blend based Bias Truck Tyre Tread Cap.

2.1. Mooney viscosity, stress relaxation and Mooney scorch

The Mooney viscosity, stress relaxation and Mooney scorch results are shown in Table 2.

Rubber compounds mixed with natural oils showed higher Mooney viscosity in both themaster and final batches. Comparable stress relaxation was observed in all the three compounds. Higher scorch safety was observed in compound mixed with NO_2 oil.

2.2. Flow behavior (frequency sweep)

The power law index results for master and final batches are shown in Table 3.

Rubber compounds having natural oils showed marginally better flow behavior properties for both the master batch and final batch.

2.3. Filler dispersion study

The results for dispersion study for master and final batches are shown in Table 4.

In master batches compounds having NO_2 oils showed better, whereas rubber compounds having NO_1 oil showed poor filler dispersion. In final batches, compounds having NO_1 oils showed better filler dispersion.

2.4. Polymer–filler and filler–filler interaction study

The results for polymer–filler interaction study for the master and final batches are shown in Table 5. The rubber compounds having both the natural oils showed poor polymer–filler interaction for themaster batch. The rubber compounds having NO_2 oil showed better polymer–filler interaction for the final batch.

2.5. Rheometric properties. The rheometric results are shown in Table 6.

Marginally lower maximum torque was observed in the case of compounds mixed with natural oils. Rubber compounds having NO_2 oil showed higher scorch safety, which was further confirmed by Mooney scorch results [11].

3. Improving sidewall rubber.

Characterization of NR/BR/RR

3.1. Composites reinforced with CB.

The mechanical properties including tensile strength, elongation at break, modulus at 100 % elongation of the samples were tested with universal testing machine (Instron 3365, Instron) at a speed of 500 mm/min, and the samples were in the shape of dumb-bell according to standard ASTM D412–2009 (Table 7). The dispersion of gel fraction was observed by OM (Leica DM LP, Leica Instruments, Germany). The gel fraction was dispersed in toluene under ultrasonic condition before subjected to OM observation. The dispersive behavior of gel fraction in the vulcanizates was investigated by desktop scanning electron microscope (DSEM) (Phenom Pro, Phenom Corp., The Netherlands). The tensile fraction surface of the vulcanizates was subjected to metal spraying and then been observed under DSEM. The dynamic mechanical properties of the vulcanizates were indicated by DMA (Discovery DMA 850, TA Instruments).

The tests were carried out in the tensile mode. The temperature ranged from _120 to 70_C, and the heating rate was 3_C/min. The frequency was 10 Hz, and the strain was 0.1 %.

The flexing fatigue resistance of the compounds were manifested by a rubber flexing fatigue tester (GT-7011-D, Gotech Testing Machines, China) with a frequency of 20 Hz at room temperature, according to standard ISO 132:1999.

Table 7 – Composition analysis of gel particles in RRs determined by TGA

Composition	R1 (%)	R4 (%)	R7 (%)
Rubber hydrocarbon	30	40	50
CB	55	48	40
Inorganic residues	15	12	10

Abbreviations: RR, reclaimed rubber; TGA, thermo-gravimetric analyzer.

3.2 Mechanical, rheological, and dynamic mechanical performance of NR/ BR/RR composites reinforced with CB.

Figure 2 shows the variation of storage modulus (G0) with strain.

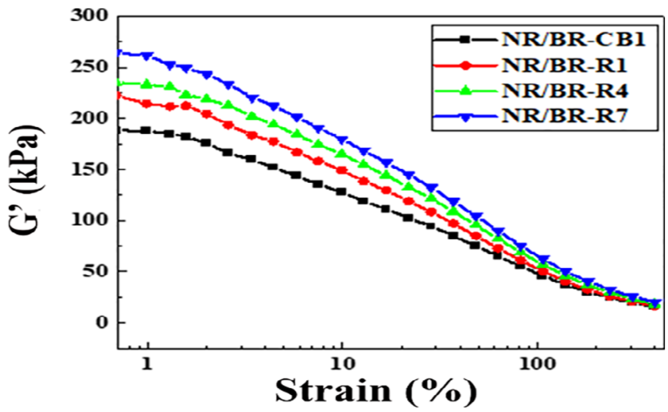

Figure 2 – Payne effect of NR/BR/RR reinforced with CB. BR, butadiene rubber; CB, carbon black; NR, natural rubber; RR, reclaimed rubber [Color figure can be viewed at wileyonlinelibrary.com]

The storage modulus of the rubber compound shows a nonlinear decrease with the increase of strain, which is the typical Payne effect [13].

The Payne effect represents the magnitude of the interaction force between the rubber matrix and the filler. Further exploring the dispersive behavior of RR in the rubber compounds, it was found that the addition of RR can significantly increase the G0 compared with pure CB, which is mainly due to the presence of the bound rubber. The CB coated by bound rubber is more entangled with the molecular chain of the rubber matrix, and has a better compatibility. In addition, as the degree of reclaiming increased, the Payne effect weakened, indicating reduction of filler aggregates, that is, the filler has a better dispersion in the matrix.

The dispersive behavior of the gel particles in the compounds was further analyzed. By observing the tensile fracture surface of the vulcanizates, as shown in Figure 3, it was found that compared with NR/BR-CB1, the addition of RR increased the roughness of the tensile fracture surface. In addition, the dispersive size of the gel particles decreased with the degree of reclaiming. The surface of NR/BR-R1 was similar to NR/BR-CB1 with less and smaller size of gel particles, which confirmed the micro-nano structure of R1. While in NR/BR-R4 and NR/BR-R7, the particle size of gel fraction increased significantly and was easy to be the stress concentration point in the range of tens to hundreds of microns.

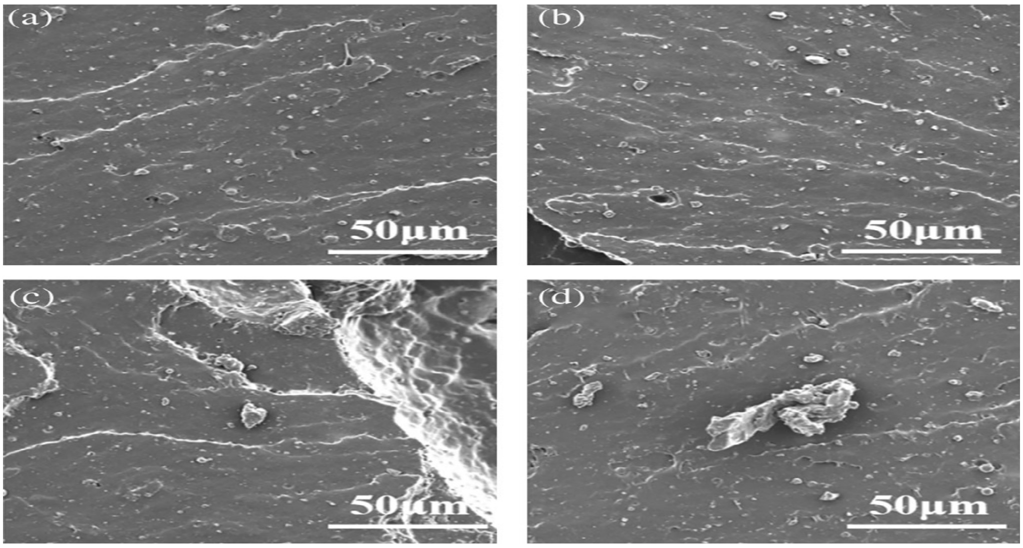

Figure 3 – Microstructure of tensile fracture surfaces of vulcanizates
(a) NR/BR-CB1, (b) NR/BR-R1, (c) NR/BR-R4, (d) NR/BR-R7BR, butadiene rubber; CB, carbon black; NR, natural rubber

Table 8 showed the influence of RR on the mechanical properties of the vulcanizates, which has also been substantiated by Rattanasom [14]. Fragmentized rubber molecular chains were obtained by reclaiming, and caused lightly degradation of mechanical properties (the tensile strength and elongation at break of the rubber were reduced from 20.2 MPa and 693 % to 17.5 MPa and 606 %, whereas stress at 100% elongation and hardness were promoted).

Table 8 – Mechanical properties of NR/BR/RR blends reinforced with CB Samples NR/BR-CB1 NR/

Samples	NR/BR-CB1	NR/BR-R1	NR/BR-R4	NR/BR-R7
Tensile strength (MPa)	20.2	18.2	17.8	17.5
Stress at 100% elongation (MPa)	1.42	1.61	1.6	1.66
Elongation at break (%)	693	656	666	606
Hardness (Shore A)	50	50	51	52
Tear strength (kN_m-^{1})	78.4	78.3	74.5	71.6

Yet the loss of tear strength gradually decreased with the increase of reclaiming degree and was more stable than the traditional RR used by Fukumori, [15] which can be attributed to the dispersive scale of RR. According to Figure 4 (b), it can be found that the addition of R1, R4, and R7 can significantly improve the wet skid resistance of the compounds contrast to NR/BR-CB1, and it increased with the decrease of the reclaiming degree.

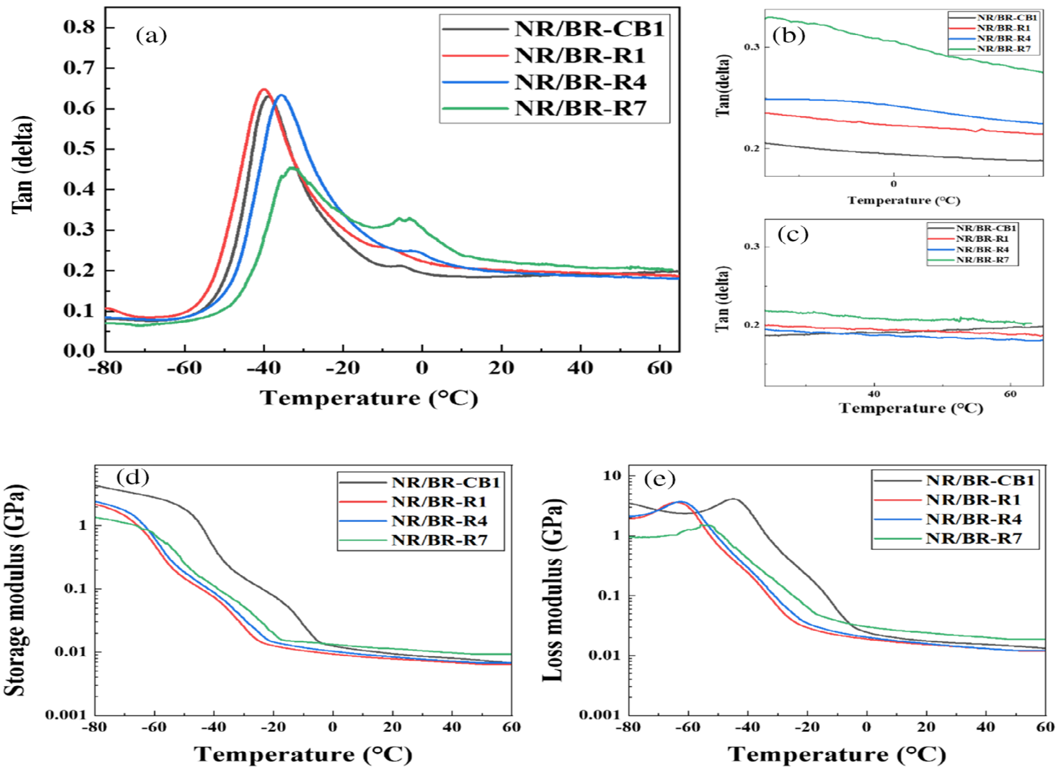

Figure 4 – Dynamic mechanical properties of NR/BR/RR blends reinforced with CB. BR, butadiene rubber; CB, carbon black; NR, natural rubber; RR, reclaimed rubber [Color figure can be viewed at wileyonlinelibrary.com]

Otherwise, the tanδ at 60 C represents the rolling resistance of the rubber, from Figure 4 (c), it can be seen that high wet skid resistance and low friction and rolling resistance cannot be realized by R7 concurrently. The hundred microns of gel particles in R7 will bring higher heat generation and energy consumption. However, R1 and R4 with higher reclamation degree can give rise to excellent dynamic mechanical properties.

Flexing fatigue life of rubber-like materials mainly depends on mechanical damage, chemical damage, and thermal damage. RR with lower Mooney viscosity can be used as a multifunctional modifier in tire sidewall, while improving aging resistance and flexing fatigue resistance at the same time. The loss of dynamic mechanical properties caused by micron gel particles can also be remitted. In addition, the sol fraction with low molecular weight and the CB covered by gel fraction can be used as substitutes for aromatic oil and part of the CB in traditional sidewall formula, which can promote the application of RR in tire sidewall and lower the cost for industrial tire manufacturing. Therefore, the RR prepared by this work is expected to be high performance fillers in tire sidewall and fulfill sustainable development of tire manufacturing [16].

Conclusion

The experiment reports the characterisation of naturally occurring oils in 100% NR based formulation, NR/BR blend and SSBR/NR/BR blend based Bias and Radial Tyre Tread formulations. It was observed that compounds mixed with naturally occurring oils showed better abrasion properties in all the cases, which was further supported by better polymer–filler interaction and filler dispersion observed in the compounds having natural oils. The improvement in the above properties may also improve the performance properties of the tyre. Thus, ecofriendly processing oils can be used in rubber industry as cost effective material [11].

For the sidewall rubber RRs with different reclaiming degree were prepared by single-screw extruder. Their composition and structure were analyzed by characterizing the sol and gel fraction of RR respectively and its influence on the performance of the compounds was also investigated. The conclusions were summarized as follows:

1 The composition and structure of RR were changed with the increase of the reclaiming degree. The Mooney viscosity of RR decreased with the reclaiming degree as well as the sole content and the content of rubber hydrocarbon in gel fraction. In addition, the molecular weight of sol fraction was reduced and the molecular weight distribution was widened.

2 After blending with NR/BR, the addition of RR was able to increase the curing efficiency of the compounds, which might be attributed to the release of contained vulcanization assistants and free sulfur radicals as the cross-linking network collapsing during the reclamation process. Also, with the advantages of low Mooney viscosity and high sol content, R1 can completely replace the aromatic oil softener in the traditional formula, improving the processability of rubber compounds.

3 Furthermore, the dispersive scale of R1, R4, and R7 in tire sidewall decreased to a micro-nano scale with the reclaiming degree. R1 and R4 can improve the wet skid resistance of the rubber compounds while reducing its rolling resistance. Moreover, R1, R4, and R7 can excellently improve the flexing fatigue resistance of the rubber

compounds 10–20 times of traditional formula, which greatly improved the dynamic mechanical properties and the flexing fatigue resistance without affecting the basic mechanical properties severely.

With advantages of excellent dynamic mechanical performance, high flexing fatigue resistance, micro-nano reclamation has potential prospects in the field of tire sidewall applications in the future [16].

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УЛУЧШЕНИЕ МЕХАНИЧЕСКИХ СВОЙСТВ РЕЗИНОВОЙ СМЕСИ АВТОМОБИЛЬНЫХ ШИН: ОБЗОР ЛИТЕРАТУРЫ

Люди переходят от использования технологических масел на основе ископаемого топлива к маслам природного происхождения, и ограничение на использование масел-наполнителей с высоким содержанием ПХА к декабрю 2009 года приводит к поиску масел природного происхождения. Согласно отчету KEMI, продукты с содержанием полициклических ароматических соединений, ПХА, превышающим 3 % по весу, должны быть маркированы. В отчете указывалось, что изношенный материал протектора шин разбрасывался по обочинам дорог, в результате чего в окружающую среду попадало большое количество ПХА. ПХА оказывает токсическое воздействие на водные организмы. Для резины боковины шины способом улучшения свойств является метод поэтапного уменьшения размера частиц геля в регенерированной резине до микро-наномасштаба, и в этой работе были представлены его превосходные динамические характеристики в боковине шины.

В настоящей работе два природных масла, масло нима и масло курунджа, были охарактеризованы в рецептуре на основе 100 % натурального каучука, смеси NR/BR на основе диагональной смеси для грузовых автомобилей и ребристых шин и смеси SSBR/NR/BR.

На основе резиновой смеси для протектора радиальных пассажирских шин. составы, изготовленные из природных масел, показали лучшие абразивные свойства. Было обнаружено, что эти масла подходят также из-за низкого содержания ПХА. Результаты для боковины шины показали, что размер частиц геля уменьшался с нескольких микрометров до микронанометров с увеличением степени регенерации, что сопровождалось снижением молекулярной массы и расширением молекулярно-массового распределения золь-фракции. Добавление регенерированного каучука с низкой вязкостью по Муни эффективно улучшало динамические механические свойства смесей натуральный каучук/бутадиеновый каучук, включая влагостойкость и сопротивление качению. Кроме того, сопротивление усталости при изгибе также было улучшено в десятки раз по сравнению с традиционными боковинами шин.

Ключевые слова: резина нити шины, резина боковины шины, наноструктурные полимеры, неполимерные материалы и композиты, резина.

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АВТОМОБИЛЬ ШИНАЛАРЫНЫҢ РЕЗЕҢКЕ ҚОСПАСЫНЫҢ МЕХАНИКАЛЫҚ ҚАСИЕТТЕРІН ЖАҚСАРТУ: ӘДЕБИЕТКЕ ШОЛУ

Адамдар қазба отынына негізделген майларды пайдаланудан табиғи майға ауысады, ал PCA-мен байытылған майларды шектеу 2009 жылдың желтоқсанына дейін табиғи майларды іздеуге әкеледі. KAMI есебіне сәйкес, құрамында полициклді хош иісті қосылыстар бар өнімдер, салмағы бойынша 3 %-дан асатын PCAS таңбалануы керек. Есепте тозған шина протекторының материалы жол бойында таралып, қоршаған ортаға көп мөлшерде PCA әкелетіні көрсетілген. PCA су организмдеріне улы әсер етеді. Бүйірлік шиналарға арналған резеңкеге келетін болсақ, қасиеттерді жақсарту әдісі-қалпына келтірілген резеңкедегі гель бөлшектерінің мөлшерін микро-наномдарға дейін біртіндеп азайту және бұл жұмыс шиналардың бүйірлеріндегі керемет динамикалық сипаттамаларын ұсынды.

Осы жұмыста екі табиғи май, неем майы және курунжа майы 100 % табиғи резеңке негізіндегі рецептпен сипатталды, жүк көліктеріне арналған NR/BR қоспасы мен шиналы шиналары бар шиналар мен жеңіл шиналарға арналған радиалды шиналарға арналған SSBR/NR/BR қоспалары.

Табиғи майлардан жасалған композициялар ең жақсы абразивті қасиеттерін көрсетті. Бұл майлар PCA құрамы төмен болғандықтан да қолайлы деп танылды. Шинаның бүйір қабырғасының нәтижелері гель бөлшектерінің мөлшері регенерация деңгейінің жоғарылауымен бірнеше микрометрден микронометрлерге дейін төмендегенін көрсетті, бұл молекулалық массаның төмендеуімен және күл фракциясының молекулалық-массалық таралуының кеңеюімен бірге жүреді. Мунидің төмен тұтқырлығы бар қалпына келтірілген Каучукты қосу табиғи резеңке және бутадиен резеңке қоспаларының динамикалық механикалық қасиеттерін, соның ішінде ылғалға төзімділік пен жылжымалы қарсылықты тиімді жақсартты. Сонымен қатар, иілу кезіндегі шаршауға төзімділік дәстүрлі шинаның бүйір қабырғасымен салыстырғанда ондаған есе жақсарды.

Кілтті сөздер: шина жіп резеңке, шинаның қабырғасының резинасы, наноқұрылымды полимерлер, полимерлік материалдар және композиттер, резеңке.

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