Property Enhancement of Natural Rubber by Blending with Rice Husk Ash and PET Powder

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ABSTRACT:

Rubber industry is a well-established industry with a growing demand in modern world. Rice husk ash and PET (Poly Ethylene Terephthalate) powders are gaining interest as fillers in rubber compounding. RHA filler results in improved hardness but decreased tensile strength and tear strength, lower Mooney viscosity, shorter cure time. Use of PET powder as a filler results in decrease of cross link density, tensile strength and reduced curing time. This study is conducted to analyze the property enhancement of natural rubber by introducing rice husk ash and PET powder as alternatives for carbon black. Mechanical properties, Thermal stability and morphology of the resulting samples were investigated.

KEYWORDS: Compounding, Rubber, Filler, Mechanical properties.

INTRODUCTION:

Rubber is a compound which is consumed highly due to its wide range of properties like high strength, stretchiness, elasticity, durability and waterproof quality, which are desirable for many applications. Tire manufacturing, Packaging, Insulation, Adhesives, Protective gloves, Paint industry, Table and chairs, Roofing membranes, Waterproof clothes/gaskets and usual things like pencil erasers, balloons, cups and plates are products of rubber and the range of application is very broad. Fillers enhance the rubber properties by reinforcing the rubber, improving the hardness of rubber, increasing the volume of rubber for low cost production, facilitating processing of rubber and enhancing age resistance (some fillers only). Fillers can be classified as Particulate (powders) and Non-particulate (resinous and fibrous) fillers, Reinforcing/semi reinforcing or non-reinforcing (diluents) fillers, Black and non-black fillers.

Normally the filler used for rubber compounding is carbon black, which is expensive and non-renewable. So low cost alternatives for carbon black with enhanced properties are obtaining popularity. Rice husk ash is the filler substitute chosen and apart from that, PET bottle powder will be mixed to enhance the quantity. Rice husk ash is an agricultural waste, which has gained an importance in the polymer industry due to the advantages such as the light weight, low cost and being environmentally friendly. As a type of natural fiber obtained from agricultural waste, RH can be developed to use as a filler in composites materials based on polymer applications. The weak adhesion interfaces and phase separation between PET and rubber are an issue resulting from immiscibility between two components.

The compatibility of these fillers has to be checked with varying the properties of the filler such as filler composition, filler percentage, filler ratio, particle size of the filler, particle size distribution. Since we hope to analyze the effect of filler, the other parameters such as chemicals, mixing speed, temperature, time duration for compounding were kept constant for each sample.

METHODOLOGY:

Materials

As the type of rubber, smoked dry rubber sheets grade RSS3 was chosen. Selected rice husk mainly consisted of 30% to 50% of organic carbon with bulk density of 90 -150 kg/m^3. PET powder was grinded to achieve the particle size range of 3-10 micrometers. To improve the surface interaction HDPE powder was also added to the PET powder mixture.

Preparation of Raw Materials

Bulk amount of rice husk was taken from local supplier throughout the research. The ash was prepared by burning the rice husk using open field method at a temperature of 600^{0}C in a muffle furnace for one hour. The particle size of the Carbon black used was in 3 to 10 micrometers. Size of the PET bottles were reduced by a shredder.

Experimental Procedure

Rubber was heated at 75^{0}C for 5 minutes in brabender mixture and zinc oxide, steric acid, resin and antioxidant were added and it was kept for further 2 minutes. Then carbon black was added and it heated up to 95^{0}C and at the final stage sulfur was added and temperature was increased to 115^{0}C and was kept for 3 minutes. Samples were unloaded and using compression molding, thin sheets were prepared for the testing.

Samples were prepared as follows,

Table 3 Sample preparation

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Dry Rubber	**100**	**100**	**100**	**100**	**100**
Sulfur	**30.50**	**30.50**	**30.50**	**30.50**	**30.50**
Zinc Oxide	**5.00**	**5.00**	**5.00**	**5.00**	**5.00**
Butyl Benzothizole	**0.75**	**0.75**	**0.75**	**0.75**	**0.75**
Steric Acid	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Carbon Black	**0**	**20.00**	**35.00**	**20.00**	**0**
RHA	**20.00**	**10.00**	**0**	**5.00**	**15.00**
PET Powder	**15.00**	**5.00**	**0**	**10.00**	**20.00**
	145.25	**145.25**	**145.25**	**145.25**	**145.25**

Analytical methods

Rheological and physical properties were measured and compared with the properties of sample number 3.

RESULTS AND DISCUSSION

For the testing of above parameters, samples have to be prepared into thin sheets for the specimen preparation. The prepared samples were stickered and the bubbles were formed during compressing into thin sheets. Therefore, those samples were not in a proper condition to check in universal tensile tester, hardness tester, vertical rebound resilient tester and etc. For testing of rheological property, samples were inserted to the sealed cavity oscillating rheometer. Based on the graph provided by the equipment rheological properties were determined.

According to the developed samples it could be seen that the mixing of the three main filler components are not compatible to each other. From the visual structure, it was observed that those were not bound with each other with proper bonding. It is better to take the SEM photos for the modified samples to check their morphology. Then the actual structure in micro scale can be concluded and issues can be identified.

CONCLUSION

According to the rheological property test, it can be concluded that blending with rice husk ash and PET bottles leads to reduction of the desirable properties. To improve the physical properties after compounding, compatibilizer percentage can be increase.

REFERENCES

Association, E. t. (2012). *Reinforcing fillers in the rubber industry.*

Chae, S. (2000). Rheological properties of polymers.

Cristina Cazan, M. D. (2015). Effect of PET functionalization in composites of rubber-PET-HDPE type. *Arabian journal of chemistry*.

Davoudi, K. (2013). Mechanical properties of polymers.

Dibyendu , D., Saha, A., & Bhattacharjee, H. (2016). Rubber Processing is detrimental to environment: A case study. *International Journal of Scientific & Engineering Research, 7*(7), 369-377.

Duffy, J. (2015). Measuring the rheology of polymers.

M.Bijarimi, Z. H. (2010). Mechanical properties of industrial tyre rubber compounds. *Applied science*.

Maghami, S. (2016). Silica filled tyre tred compounds.

Mechanical properties of polymer. (2018). Retrieved July 16, 2018, from http://www.pslc.ws/macrog/mech.htm

Mohamed, R. (2005). Properties of rubber blend based on natural rubber loaded with different fillers and cured by gamma radiation.

N.Cardona, C. (2018). Posibilities of rice husk ash to be used as reinforcing filler in polymer sector. *17*.

R.Zafarmehrabian, S. G. (2012). The effect of silica/carbon black ratio on the dynamic properties of the tread compunds in truck tyres.

S.Ertong, P. (1990). Rheological properties of rubber compunds. Elsevier science.

ThompsonsGroup. (2011). *Natural rubber*. Retrieved July 14, 2018, from http://www.thomsonrubbers.com/natural_rubber.html

Thompsonsgroup. (2011). *Natural rubber grades*. Retrieved July 14, 2018, from http://www.thomsonrubbers.com/grade_specification.html

W.Arayapranee. (2012). Rubberr abrasion resistance. In *Abrasion resisitance of materials.*

Z.A.M Ishak, A. B. (1994). An investigation on the potential of rice husk ash as fillers for epoxidized natural rubber.