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Mechanical properties and morphology natural rubber blend with bentonit and carbon black

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Abstract. Purpose of this study was to determine the mechanical properties and morphology of composite natural rubber and natural bentonite with addition of Na-bentonite filler and carbon black to natural rubber. The method is carried material mixed with filler composition variations (0,10,20,30) phr using open mill for 6 min. Results of the open mill is vulcanized at a temperature of 170°C. Further testing mechanical properties and morphology. Results showed that the addition of Na-bentonite filler and carbon black influence on the mechanical properties of tensile strength, elongation at break, modulus of elasticity, hardness, and strong tear. Morphological results showed cavities in the rubber compound and the occurrence agglomeration.

1. Introduction

Natural rubber has properties of plasticity or viscosity, elasticity, tensile strength, and. But that is not polar nature and content of the high unsaturated bond in the molecule, natural rubber is not resistant to oxidation, ozonation, heat and expand in the oil. To improve the quality of the rubber, engineering conducted on the rubber usually by adding filler with the aim to improve the performance of the rubber. One of the most common fillers used is carbon black. Carbon black filler material is active or reinforcing fillers are able to add hardness and resilience tear, abrasion resistance, and high tensile strength on the goods produced [1-2]. Reinforcing fillers generally have a small particle size, surface active chemical, which has a porous surface and a non-uniform shape can improve adhesion [3]. Particles of inorganic filler material for polymers have been used widely because generally cheaper financing. Fillers are frequently used, fiber glas, mica, talc, SiO₂ and CaCO₃, usually forming micro-composites with improved properties [4]. Bentonite is a type of clay that contains mineral montmorillonite more than 85% with the chemical formula is $[(OH)_4Si_8Al_4O_{20}nH_2O]$. Bentonite is divided into easy bentonite expands and can not expand. Bentonite is sodium bentonite expands is (Na-bentonite).

Clay is one of the excipients non charcoal is often used as an ingredient fillers in the rubber industry. Clay is cost minerals and has become part important in the rubber industry where its use as a filler economical to modify the creation and the performance of natural rubber and synthetic rubber. There are many types of clay, but montmorillonite has a long record as the most important inorganic



materials was added as a filler material into natural rubber [5-6]. Improved properties depend on many factors including the aspect ratio of the filler material, the degree of dispersion and orientation within the matrix, and adhesion at the interface matrix-excipients.

In this study aims to determine the mechanical properties and morphology, of composites with Na-bentonit natural rubber and carbon black as filler.

2. Experimental

2.1. Materials and Instrument

Natural rubber SIR 20, bentonite, carbon black, ZnO of PT Brataco, sulfur, stearic acid from PT brataco, wax from China, butyl hydroxy toluene (BHT), Diethyl Zinc Dithiocarbamate (ZDEC), distilled, saturated NaCl. The tools used in the characterization and manufacturing test samples is open mill, Scanning Electron Microscopy (SEM) Zeiss models, tensiometer MosantoT-10 Durometer type-A, X-Ray Fluorescence (XRF), XRD (6100 Shimadzu)

Table 1. The Composition of The Mixture of Natural Rubber Compound

Materials	Formula Compound (phr)				
	1	2	3	4	5
Natural Rubber	100	100	100	100	100
Wax	1.5	1.5	1.5	1.5	1.5
Na -bentonite	0	30	20	10	0
Carbon black	0	0	10	20	30
Stearic acid	2	2	2	2	2
BHT	2	2	2	2	2
ZnO	5	5	5	5	5
ZDEC	1.5	1,5	1.5	1.5	1.5
Sulfur	3	3	3	3	3

2.2. Preparation of Bentonite.

Bentonite natural crushed into powder using a mortar. 150 g of bentonite which had been sieved to 200 mesh was added to the glass beaker and add 500 mL saturated NaCl. The mixture is stirred with a magnetic stirrer at a temperature of 70 °C for 2 h. Then, into the mixture was added 500 mL of distilled water. The mixture is stirred for 10 min. Then allowed to stand until precipitation occurs, then the mixture is filtered and the filtrate is separated using a vacuum filter. Furthermore sediment obtained saturated NaCl was added for the second time as much as 500 mL and the mixture was stirred again for 2 h at 70 °C. Sediment obtained is separated from the solution by means filtered. Sediment obtained washed with hot distilled water. Sediment obtained dried in an oven at 120 °C for 6 h.

Preparation of rubber compound. The mixture of materials as shown in Table 1, was added to the open-mill, and then milled until completely solid rubber, rubber While the passage of the grinding

process, the materials inserted one by one gradually for 6 min. Results of the open mill is vulcanized at 170°C

3. Results and Discussion

3.1 Mechanics Analysis

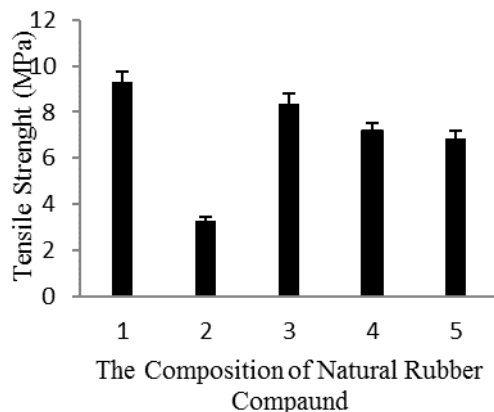


Figure 1. Tensile Strength of the Composition of Natural Rubber Compound

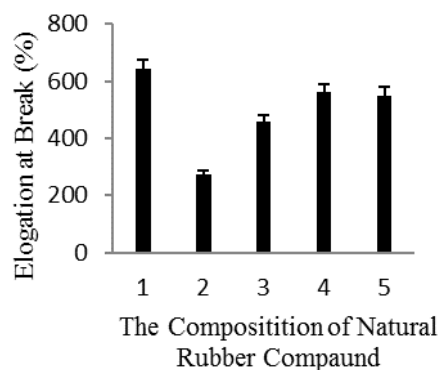


Figure 2. Elongation at Break of the Composition of Natural Rubber Compound

From Figure 1 tensile strength values obtained rubber compound with fillers decreased compared with the tensile strength of rubber compounds without fillers. This is due to the rubber compound is not affected fillers, so it does not slow down the vulcanized rubber. And the value of tensile strength is the smallest in the sample 2, namely rubber compound with 30 phr filler Na-bentonite. This is because Na-bentonite siliceous which have high acidity that can inhibit vulcanized rubber resulting in lower density crosslinked with vulcanized natural rubber as filler silica. Continued decline in the density of cross causing chains of the rubber molecules are easy to move and not rigid. This is according to [7], also contains carbon that is high enough so as to reduce the value of tensile strength.

Elongation at break is one of the physical properties of the finished goods of rubber, to determine the nature of the elasticity of the product that will show to what extent the product may be stretched to the right in place. In Figure 2 the greatest value of the elongation at break is on the sample 1 is a rubber compound without filler materials with an elongation at break of 643.33%, this is due to the sample 1 does not use filler material so that the resulting rubber compound is not rigid. Sertainly easy to stretch and have the value of the elongation at break.

The value of the elongation at break is the smallest in the sample 2, namely rubber compound with 30 phr filler Na-bentonite with an elongation at break of 273.33%, this was due Na-bentonite siliceous which is rigid so that the resulting compound is difficult to stretch the resulting value of the

extension breaking low. also contains carbon that is high enough and can reduce the value of the elongation at break.

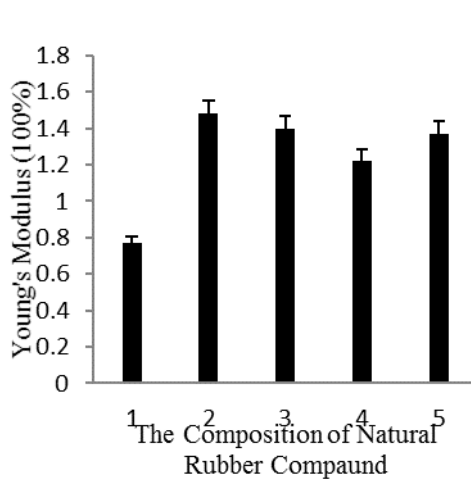


Figure 3. Young's Modulus (100%) of the Composition of Natural Rubber Compound

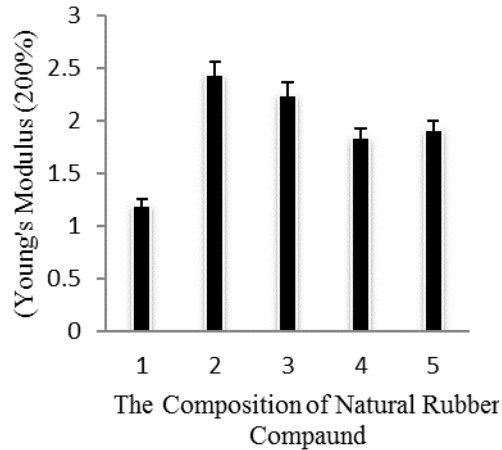


Figure 4. Young's Modulus (200%) of the Composition of Natural Rubber Compound

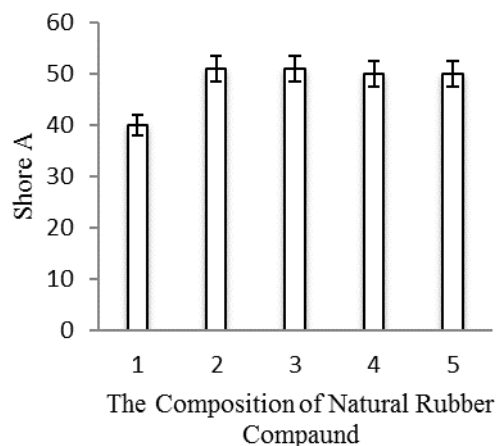


Figure 5. Shore A of the Composition of Natural Rubber Compound

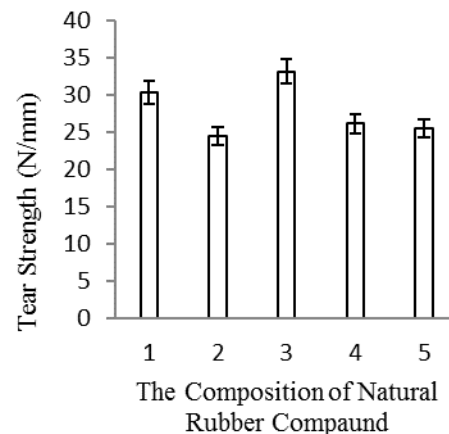


Figure 6. Tear Srength A of the Composition of Natural Rubber Compound

Figure 3 modulus of elasticity (100%) at the highest rubber compound with 30 phr filler Na-bentonite. Value smallest elastic modulus rubber compound it is because the rubber compound is not affected by the filler so that it has a high crosslinking density, causing the value of the extension rupture increases, so that the resulting elastic modulus decreased. Similarly, the modulus of elasticity of 200% is shown in the Figure 4. In cabon black filler modulus of elasticity lower than the compound with fillers Na-bentonit. is consistent with research [8] that the addition of carbon black structure lowers the modulus value, in addition to the need for the addition of some excipients with an appropriate comparison.

Figure 5 shows that the greatest hardness in the rubber compound with 20,30 phr Na-bentonite and 10 phr carbon black, due to the high hardness rubber compound with silica fillers. This is possible because the silica as a filler material that amplifies that which would add to the violence on finished goods of rubber and can provide improvement of physical properties of rubber, increase in hardness due to the interaction of silica in the mixture tends to increase the stiffness of the mix.

Tear resistance of Figure 6 the highest value obtained in sample 3 compound with 20 phr filler Na-bentonite and 10 phr carbon black. It is possible tear resistance influenced by the inclusion of carbon black. increasing the amount of intake of carbon black then tear resistance can be decreased rapidly. The results were obtained tear resistance values were decreased with increasing the amount of intake of carbon black. From the results of this research can be used to make finished goods molding rubber soles when seen from his physical nature which include tensile strength, elongation at break, resilience tear, meet the standards of SNI(0778: 2009). But for the hardness properties not meet the standards.

3.2 Morphology Analysis

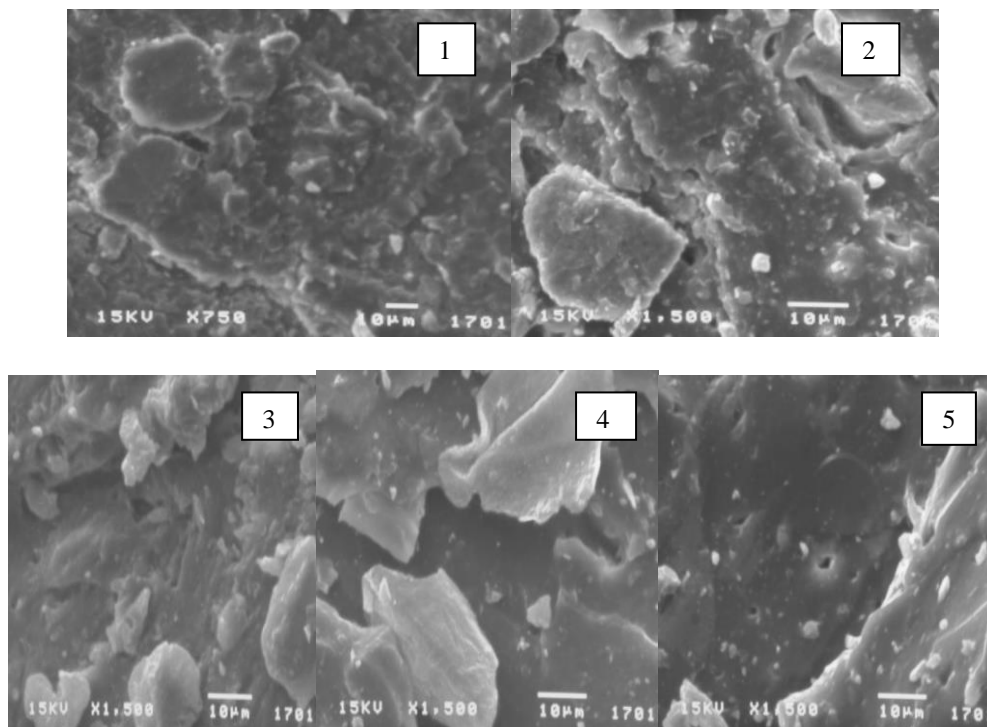


Figure 7. Morphology of the Composition of Natural Rubber Compound

The presence of cavities on the surface due to interaction between the rubber compound phase is still not good around the filler particles. This is due bentonite for their hydrophilic OH groups .It is in accordance with the results of the study [1] states that the weak interaction between these phases, is caused by the tendency of molecules of silica in rubber compounds that have hydroxyl groups form

hydrogen bonds between the molecules of silica or other chemical material which is polar. For rubber compound with 20 phr filler Na-bentonite and 10 phr of carbon black in Figure 7(3) is obtained from the surface of the rubber compound that lack of homogeneity

This is due to the uneven distribution of particles is possible because mixing chemicals rubber compound rubber uneven. The presence of cavities on the surface due to interaction between the rubber compound phase is still not good on the filler. While carbon black is hydrophobic because of their carboxyl group of around porous compound rubber composition Na-bentonite more than carbon black affecting its mechanical properties, in this case the tensile strength, hardness, resilience tear higher compared with the composition of the rubber compounds Na -bentonit fewer than carbon black.

In the rubber compound with the composition of the Na-bentonite fewer than carbon black affecting its mechanical properties, in this case the tensile strength, hardness, tear powerful lower than the Na-bentonite compound composition is more than carbon black.

For rubber compound with 30 phr filler carbon black in Figure 7(5) is obtained from the surface of the rubber compound that lack of homogeneity. This is due to the uneven distribution of particles is possible because mixing chemicals uneven rubber compound at the time open mill.

3.3 XRD Analysis

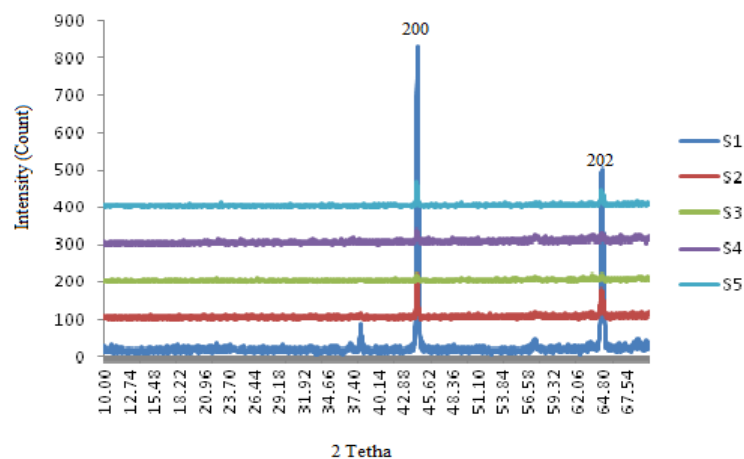


Figure 8. Diffraction of the Composition of Natural Rubber Compound

Figure 8 shows the diffraction pattern of XRD for-bentonite mixture of natural rubber and carbon black. The addition of natural bentonite into the polymer matrix of natural rubber is carried out on a different variation is (0, 10, 20, 30) phr. The figures show that there is a basal spacing of bentonite at 44.43 theta angle that is equal to 2.03 \AA with d_{hkl} 200 on natural rubber bentonite (10, 20, 30) phr, whereas the second peak at d_{hkl} 202 with angle theta 64.76, d spacing 1.43 \AA . In general, the addition of a mixture of bentonite and carbon black is almost the same diffraction pattern.

4. Conclusion

The results showed that the addition of Na-bentonite filler and carbon black influence on the mechanical properties of tensile strength, elongation at break, modulus of elasticity, hardness, and strong tear. Morphological results showed cavities in the rubber compound and the occurrence agglomeration, thereby reducing the tensile strength and elongation at break

Acknowledgments

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