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Original Research Article

Mechanical Properties of Cow Mattress Compound Reinforced Carbon Black and SIR-20

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Abstract

Cow mattress is one of the industrial products related to agriculture. Cow mattress is used for cows safety when laying down and standing up, hard type of cow mattress is usually used for cows, and soft type for calves. This research aims to find out mechanical properties of cow mattress compound reinforced with carbon black as a filler varied with SIR-20 rubber: modulus 100%, tensile strength and elongation. The results showed that the highest value of modulus 100% was 2.81 MPa at the composition of carbon black is 40 bsk , and the lowest value of modulus 100% at without carbon black, the tensile strength of hard cow mattress reached the standard value (13.52 MPa) at the composition of black caron is 40 bsk and soft type reached at the composition without carbon black (10,17 MPa), elongation of hard type cow mattress reached standard value (473%) at the composition of black carbon is 30 bs and soft cow mattress at the composition of black carbon is40 bsk (424,33%).

Keywords: Cow mattress, agriculture, black carbon.

INTRODUCTION

Natural rubber which is obtained from Havea Brasilliensis rubber plants is a polymeric compound with isoprene units as monomers. This polymer consists of carbon atoms (C) and hydrogen atoms (H) with a ratio of 5: 8. Therefore the empirical formula of natural rubber is $(C_5H_8)_n$, and n denotes the number of monomers in the polymer chain. This rubber hydrocarbon is unsaturated compounds and each isopren unit contains one double bond [1, 2].

Natural rubber has several advantages, among others, has high elasticity, good plasticity so that the processing is easy, has high wear power, high puncture resistance, high tear resistance and is not easy to heat and has a high grip, it makes natural rabber suitable for radial tires and aircraft tires [3, 4].

Based on the raw material, the rubber technical specifications produced are divided into two parts, namely:

- Latex raw materials are produced into SIR-3WF, SIR-3L and SIR-3CV.
- Raw materials for lump are processed into SIR as the quality of SIR-5, SIR-10 and SIR-20.

Standard Indonesian Rubber (SIR) is an Indonesian production of natural rubber which is sold in blocks shape and its quality is assessed in technical specifications. The assessment of quality in technical specifications is based on the results of analysis of several test conditions established for SIR, including: impurities, ash content, evaporating content, nitrogen content, initial plasticity (Po) and plasticity retenson index (PRI) [5]. This specification is a technical quality classification with the intention to provide a clearer picture of the technical characteristics of rubber so that rubber entrepreneurs can more easily manage the processing process as desired [6, 7]. The type of natural rubber that is most absorbed in the international market is the type of SIR-20, therefore it is very interesting to study more about the quality and capability of processes such as the activation energy and all that from natural rubber [8].

Black carbon is an amorphous material which is produced in thermal or oxidative decomposition of hydrocarbons which is commonly used as reinforcement for rubber, pigments and others. In 1912 a new era of black carbon purpose was found that carbon black can be added with rubber, which can add quality from rubber or resistance to scratches. The physical and chemical properties of carbon black affect the reinforcement of rubber [9]. It can be stated that

high-structure carbon black produces rubber with high modulus, not because of cross-boundary boundaries, but because of mixing which gives the ability of free radicals to react with rubber. The chemical properties of carbon surfaces are directly related to the nature of carbon black changes in rubber [10].

Cow mattress compoun is a standard compoun that is used in the manufacture of cow mattress. Cow mattress quality standards are set by PIK PT. Plantation III consists of soft and hard type, for the properties of vulcanization can be seen in the table below:

Parameter	Cow mattress standards	
	Keras	**Lunak**
Modulus 100% (kg/cm^2)	50	30
Tensile strength (kg/cm^2)	140	100
Elongation	350	450

Source: PIK PT. Perkebunan Negara III Medan

Experimental Procedure

For the first made a cow mattress compound by mixing all the ingredients in the cow mattress compound formula: SIR-20 rubber and black carbon in the ratio: 100:0, 100:20, 100:30, 100:40

The finished compound has stored in the oven at room temperature for 16-24 hours, then tested for vulcanization characteristics with the Monsanto Rheometer 100. The rheometer was heated at 170^{0}C with an oscillation angle 3^{0}C, cut the compound into small rectangular shapes for test samples /specimen.

Turned on motor and closed the testing room, then the remote button to the "on" position. After the graphic image reached its maximum (when the graph shows a flat line), stopped the testing and switched remote to the "off" position. Cooked time is known by a graph of the relationship between torque and vulcanization time.

Test specimen was pulled between two clamps in a vertical direction. The clamps was selected based on those did not give large friction to specimen, and the clamping force increased when the load increased. The direction of pulling clamp must be placed in a straight line and same direction with specimen. The measurement results of modulus, tensile strength and elongation at break can be read on printer of tensiometer recorder 100.

RESULTS AND DISCUSSION

Modulus 100%

The results of modulus 100% test for each black carbon composition are given in the table below.

Table-1: Effect of Black Carbon Composition in SIR-20 on Modulus 100%

Mixed Treatment		Modulus 100% (MPa)			Total	Mean
SIR-20	**Carbon Black (bsk)**	**I**	**II**	**III**		
100	0	1,01	1,08	1,18	3,27	1,09
100	10	1,79	1,79	1,79	5,37	1,79
100	20	1,85	1,94	1,78	5,57	1,86
100	30	2,18	2,14	2,07	6,39	2,13
100	40	2,77	2,84	2,82	8,43	2,81

The results obtained indicate that the correlation of the composition of carbon black in SIR-20 to modulus 100% can be seen in the figure below.

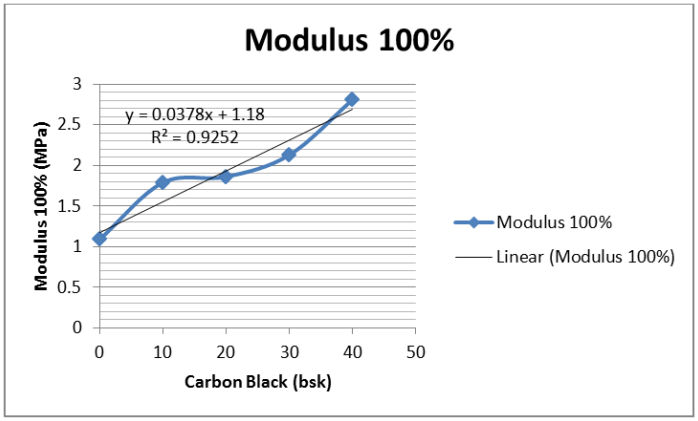

Fig-1: Graph of the Correlation of Carbon Black Composition to Modulus 100 %

Figure-1 shows that the increasing in composition of carbon black yields an increase in modulus 100% of cow mattress rubber SIR-20 compound. The highest value of modulus 100% test is 2.81 MPa with amount of black carbon = 40 bsk which is in this case for the highest composition. And the lowest of modulus 100% test is 1.09 MPa without carbon black. This is in accordance with the function of carbon black as filler material so that it can increase the quality of rubber and improve the physical properties of rubber vulcanization. Modulus 100% test of soft cow mattress reaches the standard value (2.81 MPa) at the highest composition of black carbon which is 40 bsk.

Tensile Strength

The results of tensile strength test for each black carbon composition are given in the table below.

Table-2: Effect of Black Carbon Composition in SIR-20 on Tensile Strength

Mixed Treatment		Tensile Strength (MPa)			Total	Mean
SIR-20	Carbon Black (bsk)	I	II	III		
100	0	10,54	10,96	9,02	30,52	10,17
100	10	14,44	15,23	15,03	44,70	14,90
100	20	13,17	17,02	16,18	46,37	15,46
100	30	14,57	12,01	14,56	41,14	13,71
100	40	14,20	12,20	14,18	40,58	13,53

The results obtained indicate that the correlation of the composition of carbon black in SIR-20 to tensile strength can be seen in the figure below.

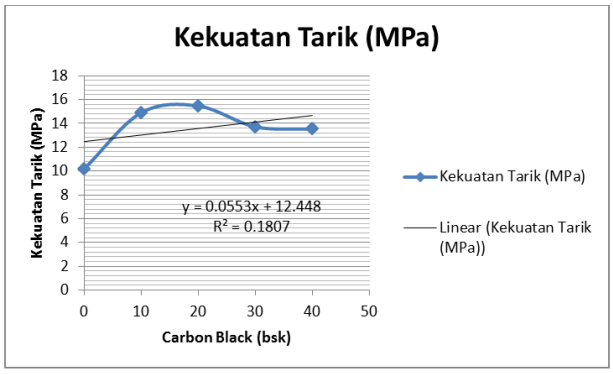

Fig-2: Graph of the Correlation of Carbon Black Composition to Tensile Strength

Figure-2 Shows that the value of tensile strength test will increase with increasing composition of the black carbon until it reaches maximum point and then will decreases with more increasing of black carbon. The value of tensile strength test reaches the maximum value at the compositions of black carbon are 10 bsk and 20 bsk, the values are 14.9 MPa and 15.46 MPa. If we continue adding amount of carbon black in cow mattress compound, value of tensile strength will decrease. This is in accordance with the function of carbon black which can improve rubber quality and increase rubber hardness. Tensile strength of hard cow mattress reaches the standard value (10.17 MPa) at the composition of carbon black is 40 bsk.

Elongation at Break

The results of elongation at break test for each black carbon composition are given in the table below:

Table-3: Effect of Black Carbon Composition in SIR-20 on Elongation at Break

Mixed Treatment		Elongation at Break (MPa)			Total	Mean
SIR-20	Carbon Black (bsk)	I	II	III		
100	0	585	574	517	1676	558,67
100	10	533	532	518	1583	527,67
100	20	493	554	554	1601	533,67
100	30	480	428	511	1419	473
100	40	448	396	429	1273	424,33

The results obtained indicate that the correlation of the composition of carbon black in SIR-20 with the elongation at break are showed in the figure below.

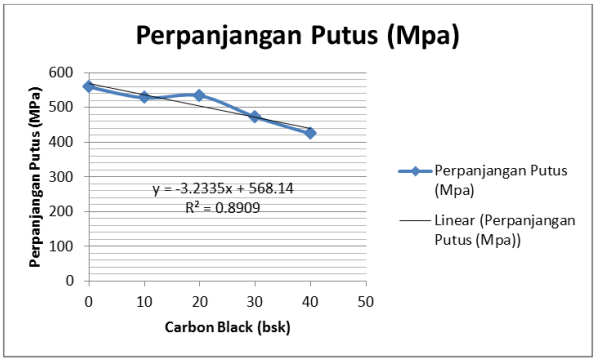

Fig-3: Graph of the Correlation of Carbon Black Composition to Elongation at Break

Figure-3 shows that the value of elongation at break test will decrease with increasing composition of black carbon. It means that if the composition of black carbon increases, the elongation at break will decrease. This is in accordance with the function of carbon black as a filler so that it can increase rubber hardness, increase rubber quality, increase volume and resistance of scratches. The value of elongation at break of hard type cow mattress reaches the standard value at the composition of black carbon is 30 bsk and soft type reaches standard value at the composition of black carbon is 40 bsk, with values are 473% and 424.33%.

CONCLUSION

- The value of modulus 100% test will increase with increasing composition of black carbon. The 100% modulus of soft cow mattress reaches the standard value (28.68 kg/cm^2) at the composition is 40 bsk.
- The value of tensile strength increases with increasing composition of black carbon until it reaches the maximum point at the composition of black carbon are 10 bsk and 20 bsk and decreases at the composition of black carbon is 40 bsk. The value of tensile strength of hard cow mattress reaches the standard value at the composition of black carbon is 40 bsk and soft cow mattress reaches the standard value at without carbon black.
- The value of elongation at break will decrease with increasing amount of black carbon. The value of elongation at break of hard cow mattress reaches the standard value at the composition of black carbon is 30 bsk and soft cow mattress reaches the standard value at the composition of black carbon is 40 bsk.

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