Effect of Different Natural Antioxidants on Tackiness and Shear Strength Properties in Natural Rubber Cump Lump Blended With EPDM Rubber as Sealant.

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Sealant based on polymer is normally used in our industry but in term of environmental friendly, there is much better raw material that can be used which is natural rubber and natural rubber (NR) cup lump is much cheaper in our industry. In term of physical properties and weathering resistance, blending with Ethylene Propylene Diene Monomers (EPDM) and antioxidants is believed to increase it physical properties and weathering resistances. The method to produce the sealant sample, the NR and EPDM will be dissolved into solution and blended together with adding the antioxidants which is curcumin and mangosteen, Methyl Ethyl Ketone Peroxide (MEKP) as curing agent and phenolic resin to improve tackiness of the sealant sample. The formulation for the sample is the same for the ratio of NR and EPDM which is 80 : 20, MEKP and phenolic resin used 5% from the total mass of sample but it is different for antioxidants where 0.5% and 1% from the total mass will be used. From the results obtained, it can says that sealant blended with natural rubber and EPDM can help in increases the physical properties but not in term of tackiness and the antioxidants that is good is curcumin and not mangosteen.

Keywords— natural rubber (NR), Ethylene Propylene Diene Monomer (EPDM), antioxidants, sealant.

I. INTRODUCTION

Natural rubber or also can be called as latex can be found from a rubber tree such as Hevea brasiliensis. Natural rubber is an elastomers which can be stretch until a certain point when applied some force on it and the can return to its original shapes [1]. Natural rubber is good in strength which is tensile and tears strength with outstanding resistance to fatigue. Besides that, it also has tackiness properties which are the ability to stick to any materials or to it and also easier to fabricated. Due to the properties of natural rubber which is resistance toward heat, light and ozone but has excellent adhesion and it is ideal in making rubber tires.

Ethylene propylene diene monomer (EPDM) is a synthetic rubber and also an elastomer. . EPDM is far much better than natural rubber in term of its physical properties where can withstand high temperature, resistance towards weathering and chemical [2] except for the elastomer properties which is the same with the natural rubber. EPDM is better due to ability to resist degradation that can be cause by weathering such as ultra violet (UV) rays and ozone. In other word, EPDM rubber is an excellent rubber to use in making product that weather resistant. The reason why EPDM can withstand weathering effect is because it only has single bond at its backbones and it called as saturated which is no effect when exposed to UV rays and ozone.

Most sealant is made from polymer such as silicone which shows good result for weathering and also in aspect of strength but in term of environmental friendly, sealant made from polymers will takes time to decompose. By using natural resources such as latex, with addition EPDM and some natural antioxidants will help in term of aging, weathering and also strength of the sealant. Besides, the natural rubber that is going to be used is from cup lump because cup lump usually been throw away and also the prize of cup lump is much more cheaper than latex [4]. The is found in solid state where it is coagulated by the acid, or in other word; cup lump is also known as vulcanized rubber [3].

Therefore by produce sealant from blending of natural rubber and antioxidant, different formulation for antioxidants is used to find the suitable percentages of the antioxidants and it can be observed by doing test towards its physical properties.

II. METHODOLOGY

A. Materials

The materials that going to be used is natural rubber (NR) cup lump, Ethylene Propylene Diene Monomer (EPDM) rubber and also two different types of antioxidants which are mangosteen and curcumin. The ratio for the NR and the EPDM is 80 : 20 and the amount of the antioxidant that will be put is 0.5% and 1% from the total mass of the sample.

B. Preparation of the Materials

Natural rubber (NR) cup lump can be buy from the rubber estate and the condition of the NR will be in solid state and a lot of impurities will be present in the NR cup lump. Therefore the NR is need to be clean by using tap water and remove all the impurities and then the size of the NR need to be reduce by cutting it down into dice shape.

The EPDM is already provided by the lab assistant and it is only needed to be cut down into small dice. For the mangosteen, the skin of the fruit needed to be dry out under the sun so that it will be easy to be crush down and turn into powder while for the curcumin powder already provided by the lab assistant.

The chemicals used in this experiment will be phenolic resin which will be the tackifier, toluene which will be the solvent and Methyl Ethyl Ketone Peroxide (MEKP) as the curing agent.

C. Blending

Before the NR turns into solution, it need to undergo mastication process where it will breakdown the molecular weight of the NR. Then NR will be dissolved into solution by adding the toluene and the ratio for the NR and the toluene is 1 : 10, and this process will take several weeks for the NR turns into solution. It is the same for the EPDM where needed to be dissolve by using toluene and also addition of the chloroform and the ratio for EPDM : toluene : chloroform is 1 : 7 : 3. Below shows the formulation table for the samples.

Table 1.0, First formulation table

	NR, g	EPDM, g	Antioxidant, g	MEKP, g	Phenolic resin, g
Sample 1	24	6	0.15	1.5	1.5
Sample 2	24	6	0.4	1.5	1.5

Table 1.1 Second formulation table.

	NR, g	Antioxidant, g	MEKP, g	Phenolic resin, g
Sample 1	30	0.15	1.5	1.5
Sample 2	30	0.4	1.5	1.5

Each of the sample from table 1.0 and 1.1 needed to prepared double samples because another sample will be test for after aging because want to see the effect of the antioxidants before and after aging.

D. Testing

For test the tackiness of the sample, the sample will be placed on a substrate and cellophane will be used in this test. The cellophane will be sticking to the surface of the sealant sample for 30 second and the removed it. The area that covered on the cellophane tape will be considered as the tackiness ability of the sealant. The area on the cellophane will be observed and measured.

Next for the tensile test, a machine will be used to test the tensile strength. The sealant sample will be put in between two substrates and the substrate will be attached to the machine and the machine will pull the substrate to see the strength of the sealant.

III. RESULTS AND DISCUSSION

A. Shear Strength Test

The sample that has been prepared is test by using the Tensile Instron Tester and the speed for the tester is set to 10mm/s which indicate that the speed for the tester pull the substrates sample until the substrates end joint pull apart. The value that wants to be obtained for the result is the maximum stress of the samples where higher value of maximum stress indicates that the samples can withstand high stress applied to it.

Before aging

i. Sealant sample 1

Table 2.0 : 24g NR, 6g EPDM, 0.5%(0.15g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	0.39	0.48
Aluminum	3.20	5.39
Glass	0.13	0.35

Table 2.1 : 30g NR, 0.5%(0.15g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	0.5	0.46
Aluminum	2.14	0.78
Glass	0.1	0.09

ii. Sealant sample 2

Table 2.3 : 24g NR, 6g EPDM, 1%(0.4g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	0.62	0.25
Aluminum	4.16	3.95
Glass	0.17	0.29

Table 2.3 : 30g NR, 1%(0.4g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	1.04	0.72
Aluminum	3.16	7.62
Glass	0.08	0.21

From the result shown in table 2.1 until table 2.3, curcumin shows a better result in sealant sample blended between natural rubber and EPDM on aluminum substrates while mangosteen shows positive results on sealant sample has 100% content natural rubber. In term of antioxidants curcumin is much better due to the ability to build its own free radicals; therefore risk for substances to damage by free radical can be avoided. For substrates, aluminum is good with the used of sealant because of because aluminum has solid form and aluminum does not have any effect to the liquid present on the sealant therefore aluminum will not swollen and there will be no physical degradation to the aluminum.

After aging

i. Sealant sample 1

Table 2.4 : 24g NR, 6g EPDM, 0.5%(0.15g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	0.44	0.08
Aluminum	7.73	5.27
Glass	0.25	0.33

Table 2.5 : 30g NR, 0.5%(0.15g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	0.28	0.33
Aluminum	4.08	8.38
Glass	0.42	0.17

ii. Sealant sample 2

Table 2.6 : 24g NR, 6g EPDM, 1%(0.4g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	0.25	0.75
Aluminum	6.85	4.18
Glass	0.42	1.13

Table 2.7 : 30g NR, 1%(0.4g) antioxidants.

Type of substrate	Maximum Strength (MPa)	
	Curcumin	Mangosteen
Wood	2.79	0.20
Aluminum	7.00	7.93
Glass	0.74	0.17

For after aging results from table 2.4 until table 2.7, the sealant shows the same results as before where curcumin is good with sealant made from natural rubber and EPDM while mangosteen is good with sealant made from 100% content of natural rubber and both sealant shows positive result with aluminum substrates. For aging process, the result shows a positive results where even though the sample were left alone in the environment and weathering, the maximum strength stress can be withstand by the sample was still strong. It shows that the present of the antioxidants in the sealant improve the weathering properties for the sealant.

B. Tackiness Test

The tackiness test had been done by using the cellophane with the adhesives properties to the rubber surface with the moderate pressure applied to the entire sample. When the cellophane covered the sample surface, there will be area that covered to the cellophane and that area was measured by using the graph paper where the cellophane is stick to the graph paper calculated by using the area of each square on the graph paper. The calculation used to calculate percentage is shown below.

$$\frac{Covered\ area}{Total\ area}\ x\ 100\% = percentages\ of\ covered\ area$$

Before aging.

i. Mangosteen

Table 3.0 : the percentage area cover by the sealant sample

Type of sealant	Area of the sealant (mm^2)	Area covered by the sealant on cellophane tape (mm^2)	Percentage covered by sealant on the cellophane tape (%)
24g of NR, 6g of EPDM, 0.5% (0.15g) mangosteen	2000	300	15.00
30g of NR, 0.5% (0.15g) of mangosteen	2648	1328	50.15
24g of NR, 6g of EPDM, 1% (0.4g) of mangosteen	1880	1000	53.19
30g of NR, 1% (0.4g) of mangosteen	2280	1592	69.82

ii. Curcumin

Table 3.1 : the percentage area cover by the sealant sample

Type of sealant	Area of the sealant (mm^2)	Area covered by the sealant on cellophane tape (mm^2)	Percentage covered by sealant on the cellophane tape (%)
24g of NR, 6g of EPDM, 0.5% (0.15g) curcumin	2540	2036	80.16
30g of NR, 0.5% (0.15g) of curcumin	1796	1596	88.86
24g of NR, 6g of EPDM, 1% (0.4g) of curcumin	2480	2172	87.58
30g of NR, 1% (0.4g) of curcumin	2244	2084	92.87

From the results obtain from table 3.0 and table 3.1, it shows that the tackiness for sealant sample made from 100% content of natural rubber is much better compared to the sealant made from blended of natural rubber and EPDM while for the antioxidants, curcumin shows a better results compared to mangosteen.The EPDM rubber had cause the tackiness effect for the sealant. Therefore the natural rubber alone had already good tackiness properties.

After aging.

i. Mangosteen

Table 3.2 : the percentage area cover by the sealant sample

Type of sealant	Area of the sealant (mm^2)	Area covered by the sealant on cellophane tape (mm^2)	Percentage covered by sealant on the cellophane tape (%)
24g of NR, 6g of EPDM, 0.5% (0.15g) mangosteen	2104	228	10.84
30g of NR, 0.5% (0.15g) of mangosteen	2344	1772	75.60
24g of NR, 6g of EPDM, 1% (0.4g) of mangosteen	2032	740	36.42
30g of NR, 1% (0.4g) of mangosteen	2368	1124	47.47

ii. Curcumin

Table 3.3 : the percentage area cover by the sealant sample

Type of sealant	Area of the sealant (mm^2)	Area covered by the sealant on cellophane tape (mm^2)	Percentage covered by sealant on the cellophane tape (%)
24g of NR, 6g of EPDM, 0.5% (0.15g) curcumin	1540	1372	89.09
30g of NR, 0.5% (0.15g) of curcumin	1944	1824	93.83
24g of NR, 6g of EPDM, 1% (0.4g) of curcumin	1660	1428	86.02
30g of NR, 1% (0.4g) of curcumin	1720	1624	94.42

From the results shown in table 3.2 and tale 3.3, it shows that the sealant sample made from natural rubber alone had strong tackiness compare to the sealant made from natural rubber blended with EPDM. In term of antioxidants, curcumin is much better compare the mangosteen even though the sample had been exposed to environment and curcumin is a good antioxidant which its ability to build its own free radicals; therefore risk for substances to damage by free radical can be avoided.

IV. Conclusion

In conclusion, the sealant blended with natural rubber and EPDM rubber can be used to increase the physical strength of the sealant but in term of tackiness, the sealant made from 100% content of natural rubber is much better and can produce much better tackiness effect. For the antioxidants, the curcumin is much better that mangosteen even in term of healthy food, mangosteen has low nutrient density and that is why curcumin is much better compared to the mangosteen.

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References

[1] Anonymous. (n.d). Natural Rubber, Properties of Natural Rubber. Retrieved from http://www.tutorvista.com/content/chemistry/chemistryii/carboncompounds/naturalrubber.php

[2] Anonymous. (n.d). What's the Difference Between Silicone and EPDM?. Retrieved from https://www.polymersolutions.com/blog/siliconeepdm/

[3] Anonymous. (n.d). Uses of Natural Rubber. Retrieved from http://www.rubbercal.com/sheet-rubber/uses-of-natural-rubber/#bottom

[4] Anonymous. (n.d). The Rubber Economist .Retrieved from http://www.therubbereconomist.com/The_Rubber_Economist/Glossary_of_rubber_terms.html