MECHANICAL PROPERTIES OF STYRENE BUTADIENE RUBBER WITH OIL PALM TRUNK FIBER AS FILLER

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ABSTRACT

Synthetic rubber on the other hand is a rubber which is synthesized chemically. Styrene-butadiene rubber is one of them. The synthetic rubber gives different properties from natural rubber in every aspect. The objectives of this research are to investigate the mechanical properties changes in styrene butadiene rubber (SBR) filled with oil palm trunks as fillers and to check the differences in properties between the amounts of fillers used. The purpose of this research is to investigate the properties of styrene butadiene rubber blending with oil palm trunk fiber as filler. The research is based on experimental lab research. The contribution of oil palm trunk as a filler in rubber compound will decrease the burning activities and reducing environmental issues. Many researches have been done in rubber/natural filler blending in order to improve the properties of rubber with economically. The methods in this research are divided into three sections; mixing, molding, and testing. Mixing required two roll mills as a device blending rubber with filler, accelerator and vulcanizing agent. Molding required hot and cold press molding to form a sheet of product before testing. Testing required a universal testing machine to test the tensile properties of the rubber blend. Two chemical used in this swelling test; kerosene and diesel. The samples were put into two different bottles with kerosene inside one bottle and diesel inside another bottle. The time taken to complete the test was 24 hours – exactly one day. The result from testing showed that increasing amount of fillers will actually decrease the tensile strength, increase the tensile modulus and increase swelling behavior of the rubber blend. As conclusion, most of mechanical properties decrease with increasing of filler content. As recommendation, increasing the filler content might give the better result, and giving more information about capability of styrene butadiene rubber to consume more filler.

ABSTRAK

Getah sintetik di sisi lain adalah getah yang merupakan hasil campuran bahan kimia. Getah stirena butadiena adalah salah satunya. Getah sintetik memberikan sifat yang berbeza dari getah asli dalam setiap aspek. Tujuan kajian ini adalah untuk mengetahui perubahan sifat mekanik dalam getah stirena butadiena (SBR) yang diisi dengan batang kelapa sawit sebagai suapan dan untuk menyemak perbezaan sifat antara jumlah suapan digunakan. Tujuan dari penelitian ini adalah untuk mengetahui sifat-sifat campuran getah stirena butadiena dengan serat batang kelapa sawit sebagai suapan. Penelitian ini berdasarkan pada penelitian ujikaji makmal. Sumbangan batang kelapa sawit sebagai isian dalam campuran getah akan menurunkan kegiatan pembakaran dan mengurangkan masalah alam sekitar. Banyak kajian telah dilakukan dalam getah/pencampuran isian asli meningkatkan sifat getah dengan ekonomi. Kaedah dalam kajian ini dibahagikan kepada tiga bahagian; pencampuran, pencetakan, dan ujian. Mencampur memerlukan “two roll mill” sebagai campuran getah peranti dengan isian, pencepat dan agen vulcanizing. Pencetakan memerlukan “hot and cold molding press” untuk membentuk sehelai produk sebelum ujian. Ujian memerlukan mesin uji universal untuk menguji sifat tarik dari getah campuran. Dua kimia yang digunakan dalam ujian pembengkakan ialah minyak tanah dan diesel. Bahan uji dimasukkan ke dalam dua botol yang berbeza dengan minyak tanah dalam satu botol dan diesel dalam botol lain. Waktu yang diperlukan untuk menyelesaikan ujian adalah 24 jam - persis satu hari. Hasil dari ujian menunjukkan bahawa peningkatan jumlah suapan benar-benar akan menurunkan kekuatan tarik, meningkatkan modulus tarik dan meningkatkan perilaku pembengkakan getah campuran. Sebagai kesimpulan, sebahagian besar sifat mekanik menurun dengan peningkatan kadar isian. Sebagai cadangan, meningkatkan kadar isian dapat memberikan hasil yang lebih baik, dan memberikan maklumat lebih lanjut tentang kemampuan getah stirena butadiena untuk mengambil lebih banyak isian.

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LIST OF ABBREVIATIONS

SBR	Styrene Butadiene Rubber
NR	Natural Rubber
SMR	Standard Malaysia Rubber
kN	Kilo Newton
mm	Millimetre
Sec	Second
MPa	Mega Pascal
PHR	Part per hundred Rubber
CB	Carbon Black
ENR	Epoxidized Natural Rubber
6-PPD	N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylene-diamine)
CBS	N-cyclohexyl-2-benzothiazyl sulphenamide
W	Weight
μ	Micro
°C	Degree Celsius
N/cm^2	Newton per Centimetre Square
g/cm^3	Gram per Centimetre Cube

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Rubber can be categorizes into two; natural rubber and synthetic rubber. Natural rubber can be found in the form of latex, which is milky in color. The latex can be found in typical rubber trees originally from South Africa. Rubber has the ability to undergo plastic deformation and still can return to its previous form. This ability gives the rubber advantages to be selected in many manufacturing product such as tire etc.

Synthetic rubber on the other hand is a rubber which is synthesized chemically. Styrene-butadiene rubber is one of them. The synthetic rubber gives different properties from natural rubber in every aspect. Styrene-butadiene rubber has low elasticity properties; it is easy to cut and press compared to Standard Malaysian Rubber (SMR) – natural rubber type of rubber.

Styrene-butadiene Rubber (SBR) is a polymer which combines copolymer of styrene and butadiene to form whether 1,2-, *cis*-1,4-, or *trans*-1,4-unit components (Sung-Seen Choi, 2001). Sung-Seen Choi also stated that styrene-butadiene rubber depend on the component form, 1,2-, *cis*-1,4-, or *trans*-1,4-units to produce different microstructure. Styrene-butadiene rubber is commonly used in tire compounds.

Oil palm trunk fiber can be found in oil palm tree that commonly plant in Malaysia. Oil palm was brought into Malaysia from Botanical Garden, Singapore in 1870 (K. O. Lim et al., 1996). Oil palm trunk fiber can be use as a natural filler to produce different properties to rubber.

1.2 PROBLEM STATEMENTS

Rubber is a special polymer with high tensile strength and low hardness. Rubber take place in marketable as a good product such as tire, medical glove, slipper etc. Different type of products needs different type of tensile strength as well as hardness. Therefore, to reduce tensile strength and increase hardness, fillers are needed. Findik et al., (2004) stated that fillers are reinforced into rubber mixture for better performance and reducing cost.

Oil palm trees are trees with specialty to produce oil – usually to produce cooking oil. The trees produce yields that decreasing every year, which leads to the tree being replanted 25 – 30 years later after planting (K. O. Lim et al., 1996). The oil palm trunk was treated as a waste and usually was burnt at plant location (H. Yamada et al., 2010). The burning activities will led to environmental issues such as green house effect and acid rain.

The purpose of this research is to investigate the properties of styrene butadiene rubber blending with oil palm trunk fiber as filler. This research also carried out in order to check significant of different parts of oil palm trunk fiber acting as filler used to styrene butadiene rubber.

1.3 OBJECTIVES OF THE RESEARCH

There are two objectives that were carried out during this research after considering the method and raw materials used.

- To investigate the mechanical properties changes in styrene butadiene rubber (SBR) filled with oil palm trunks as fillers.
- To check the differences in properties between the amounts of fillers used.

1.4 SCOPE OF STUDY

The research is based on experimental lab research. Styrene butadiene rubber, oil palm trunk fiber and other chemicals were ordered through chemical engineering laboratory. The parts of oil palm trunk fiber that is going to be used are 0 parts, 15 parts, 30 parts, 40 parts and 50 parts. The blending was carried out at typical two rolls mill located inside chemical engineering laboratory with speed 12 rotations per minute, maximum temperature of 90 °C and minimum temperature 70°C. The molding process was done using 25 ton hot and cold molding press located at chemical engineering laboratory with maximum temperature of 165 °C and minimum temperature 155 °C.

The mechanical properties that being tests are tensile and swelling test. The tensile test was done using 50 kN universal testing machine located at manufacturing engineering laboratory. The parameter used in this test are Tensile strain at Break (Standard) (mm/mm), Load at Break (Standard) (N), Extension at Break (Standard) (mm), Tensile extension at Break (Standard) (mm), Time at Break (Standard) (sec), and Modulus (Automatic) (MPa). Swelling test was done in chemical engineering laboratory with only two chemical test; kerosene and diesel. The diesel that is being used is a typical diesel that can be bought at petrol station.

1.5 RATIONALE AND SIGNIFICANCE

Different type of products needs different type of tensile strength as well as hardness. Therefore, to reduce tensile strength and increase hardness, fillers are needed. The compatibility of styrene butadiene rubber with oil palm trunk fiber was test to determine the properties in them.

The oil palm trees produce yields that decreasing every year, which leads to the tree being replanted 25 – 30 years later after planting (K. O. Lim et al., 1996). The oil palm trunk was treated as a waste and usually was burnt at plant location (H. Yamada et al., 2010). The contribution of oil palm trunk as a filler in rubber compound will decrease the burning activities and reducing environmental issues.

CHAPTER 2

LITERATURE REVIEW

2.1 STYRENE BUTADIENE RUBBER

Synthetic rubber on the other hand is a rubber which is synthesized chemically. Styrene-butadiene rubber is one of them. The synthetic rubber gives different properties from natural rubber in every aspect. Styrene-butadiene rubber has low elasticity properties; it is easy to cut and press compared to Standard Malaysian Rubber (SMR) – natural rubber type of rubber.

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M.T. Ramesan et al., (2004) reported that blending of natural rubber/styrene butadiene rubber gives better abrasion resistance properties. This is proven that styrene butadiene rubber give boost to natural rubber in term of properties and good.

2.2 NATURAL FILLER

Many researches have been done in rubber/natural filler blending in order to improve the properties of rubber with economically. Natural filler that usually being used in research are rise husk, oil palm fiber and coconut fiber. The differences in properties of rubber product can be obtained from different filler.

2.3 OIL PALM TRUNK FIBER

Oil palm trunk fiber can be found in oil palm tree that commonly plant in Malaysia. Oil palm was brought into Malaysia from Botanical Garden, Singapore in 1870 (K. O. Lim et al., 1996). Oil palm trunk fiber can be use as a natural filler to produce different properties to rubber.

Figure 2.1: Oil palm trunk fiber.

RunCang Sun et al., (2001) reported that the oil palm trunk fiber enhance sulphate pulp properties into fair strength. Oil palm trunk fiber can be potential in increasing properties of rubber as filler. The cooperation of oil palm trunk fiber and styrene butadiene rubber might enhance the rubber properties.

2.4 CROSSLINK

Rubber processing is a must to mix rubber and filler into one, solid rubber product. Vulcanizing agent is a part of crosslink between rubber bonds. Fillers is reinforced into rubber mixture for better performance and reducing cost (Findik et al., 2004). Findik et al., (2004) also stated that, sulphur and peroxide are two common vulcanizing agents that used activation energy which increase the mechanical properties of rubber product at higher temperature.

2.5 VULCANIZATION

Vulcanization is a process where the rubber matrix is being crosslink with help from vulcanizing agents. After being vulcanized, the rubber compound became cured; with no more reaction happen causing the rubber became stable. The curing happens at high temperature within 150 – 170 °C according to their rubber properties respectively. Popular vulcanizing agents used are sulphur and peroxide.

2.6 MECHANICAL PROPERTIES

2.6.1 TENSILE STRENGTH

Many researches have been done in order to investigate the mechanical properties of rubber and natural fillers before. A.I. Khalf et al., (2010) have investigated the effect of rice husk filler in styrene butadiene rubber with the presence of maleic anhydride. The tensile strength of rubber sample increase until 25 PHR of filler content, before it start to decrease at 30 PHR. This is because of the high content of filler that may cause the poor bonding in rubber matrix causing the tensile strength to drop.

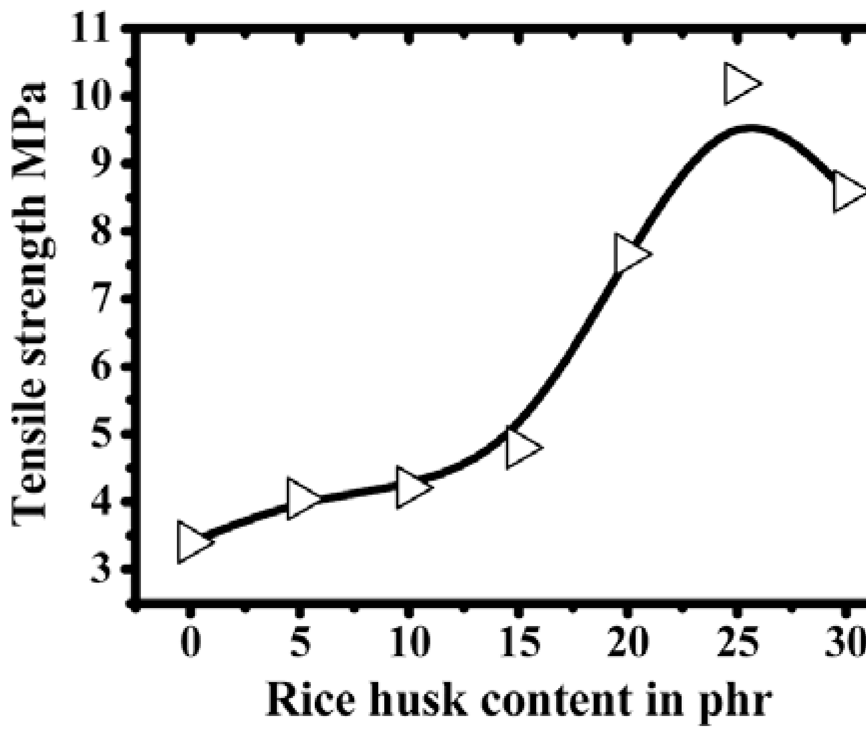

Figure 2.2: Tensile strength-rice husk content relationship (A.I. Khalf et al., 2010).

N. Rattanasom et al., (2009) on the other hand have investigated the mechanical properties of natural rubber reinforced with various fillers. Gum is virgin rubber, C6 is addition of 6 PHR of clay, CB6 is addition of 6 PHR of carbon black, CB14 is addition of 14 PHR of carbon black, S6 is addition of 6 PHR of silica and S35 is addition of 35 PHR of silica. Clay in 6 PHR quantity show promising aspect in tensile strength than the other.

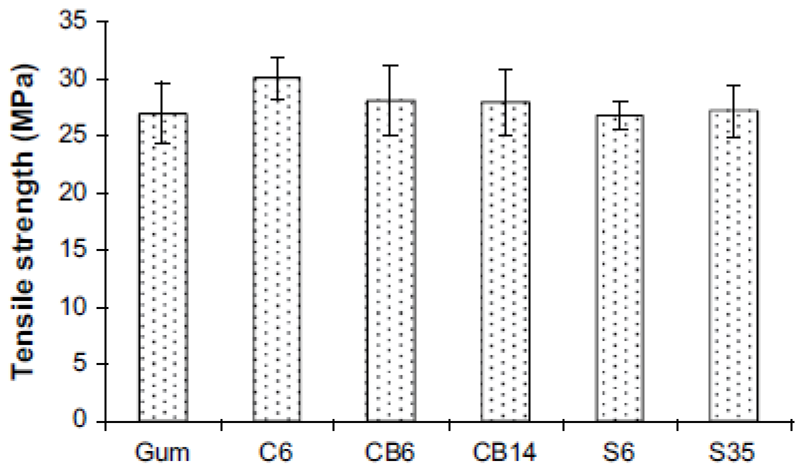

Figure 2.3: Tensile strength of natural rubber reinforced with various fillers (N. Rattanasom et al., 2009).

Hanafi Ismail et al., (1996) also have investigated the mechanical properties of ENR/oil palm wood flour. The tensile strength of rubber decreases with increasing of filler content and filler size.

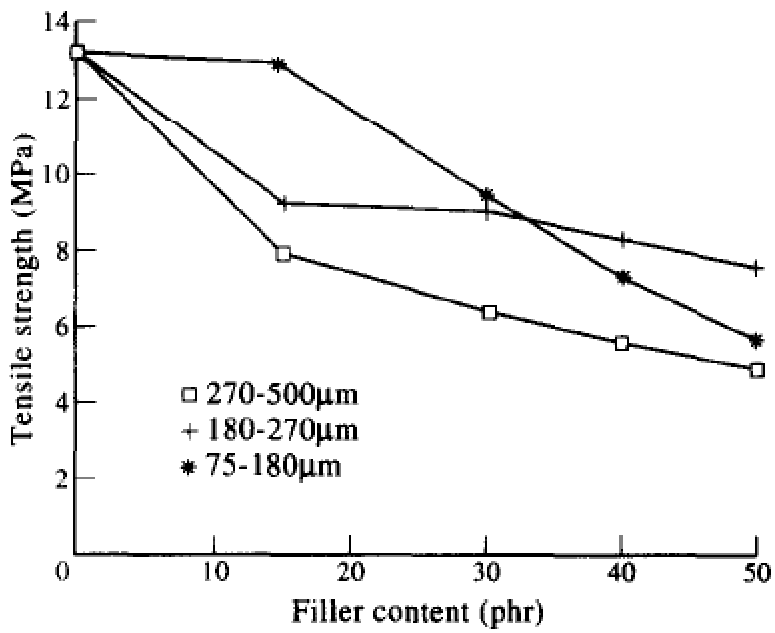

Figure 2.4: Tensile strength of rubber-filler content relationship (Hanafi Ismail et al., 1996)

2.6.2 TENSILE MODULUS

Many researches have been done to determine the tensile modulus of rubber compound. In order to check the compatibility of rubber composite, the modulus is defined in the stress-strain relationship. Hanafi Ismail et al., (2000) have determined the tensile modulus of white rice husk ash loading in natural rubber/linear low density polyethylene blends with proportional to filler content. The additions of natural filler basically increase tensile modulus of the rubber compound.

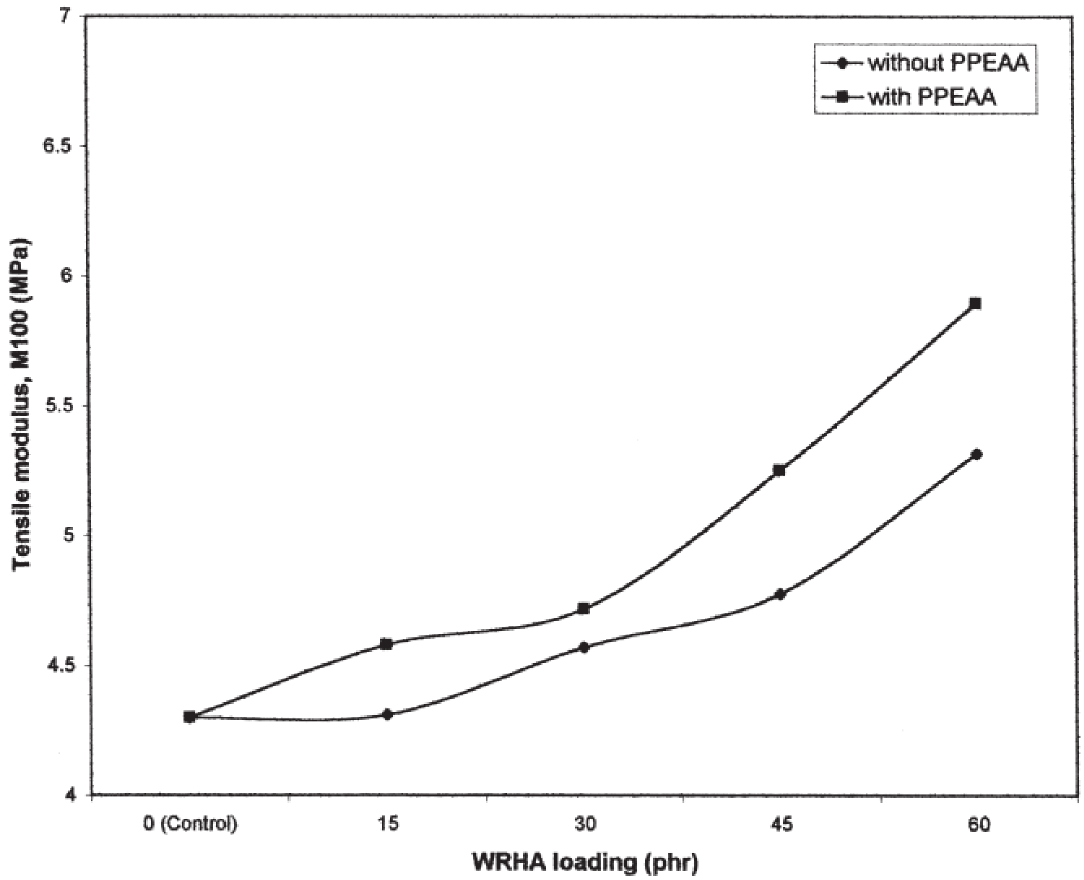

Figure 2.5: Tensile modulus of white rice husk ash loading in natural rubber/linear low density polyethylene blends (Hanafi Ismail et al., 2000).

Hanafi Ismail et al., (1999) have investigated the mechanical properties of rubber reinforced short oil palm fiber. The tensile modulus for treated rubber compound is much better than the untreated one. This is because of vulcanization process enhance the rubber properties causing the tensile modulus to increase more than untreated one.

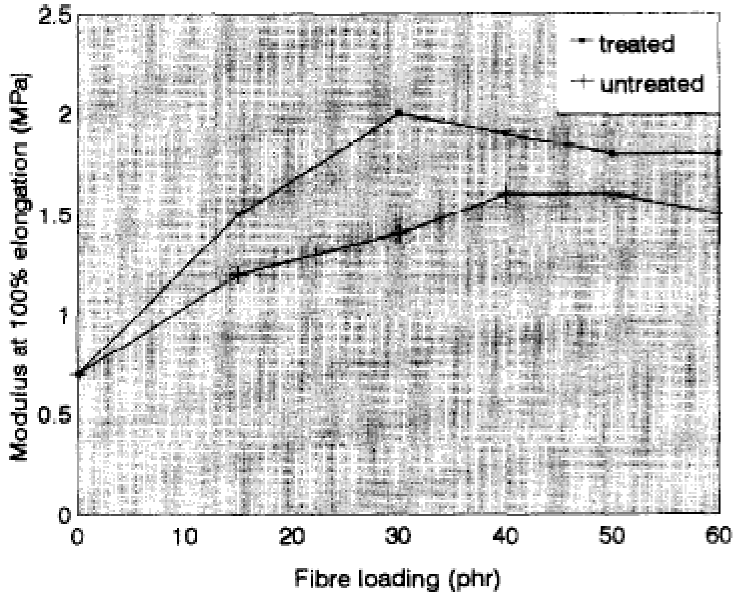

Figure 2.6: Modulus at 100% elongation according to fiber loading (Hanafi Ismail et al., 1999).

2.6.3 SWELLING

Swelling behavior is the ability of the rubber product to absorb chemical. Swelling test was done in order to check chemical resistance in rubber sample. Many researches have been done according to swelling behavior. Hanafi Ismail et al., (2001) have investigated the swelling behavior of recycled rubber powder filler on natural rubber. The more filler give more chemical resistance. As the natural rubber was filled, the rubber became more stable and increase chemical resistance ability and less chemical can be absorb.

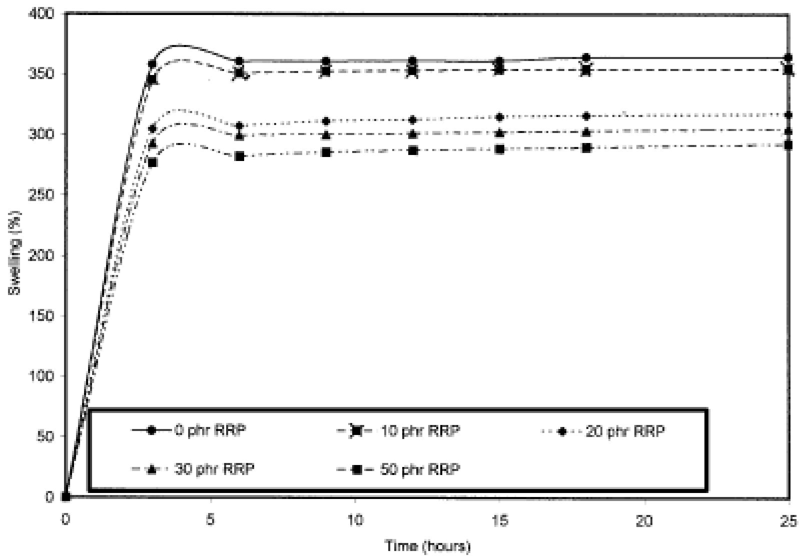

Figure 2.7: Swelling behavior of recycled rubber powder filler on natural rubber (Hanafi Ismail et al., 2001).

2.6.4 ELONGATION

Elongation before break is determined to check the ability of rubber to extend their length before break. Many researches have been done in order to determine this property. Maya Jacob et al., (2003) have investigated the mechanical properties of sisal and oil palm hybrid fiber reinforced with natural rubber. The elongation became shorter as the filler content increase. This is because of brittleness of rubber sample increase with increasing of filler loading.

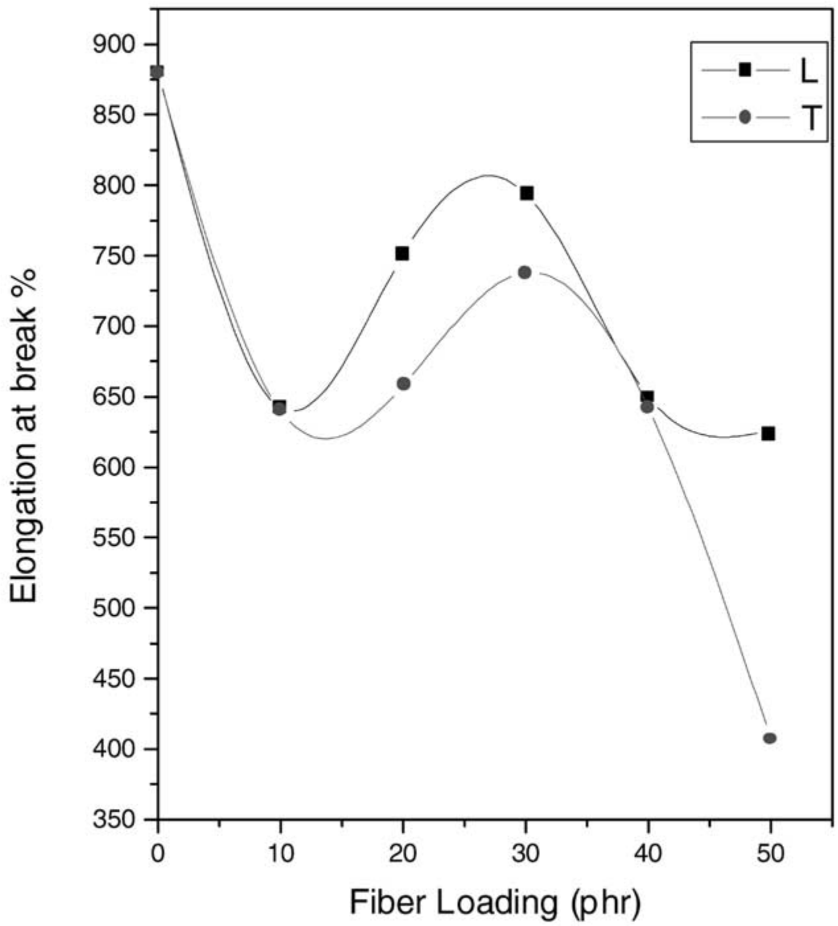

Figure 2.8: Elongation at break versus fiber loading in sisal/oil palm hybrid fiber reinforced natural rubber (Maya Jacob et al., 2003).

2.7 RECYCLED ELASTOMER

Recycling elastomer and converted it to reinforce with rubber proven economical as the filler is already in the recycled elastomer. Various researches have been done in order to determine recycled elastomer as filler properties. Noriman et al., (2009) has investigated the mechanical properties of styrene butadiene rubber (SBR) reinforced with recycled acrylonitrile-butadiene rubber (NBRr) assisted by epoxidized natural rubber (ENR-50). The tensile strength has increased with decreasing of NBRr composition but the existence of ENR-50 improved the property.

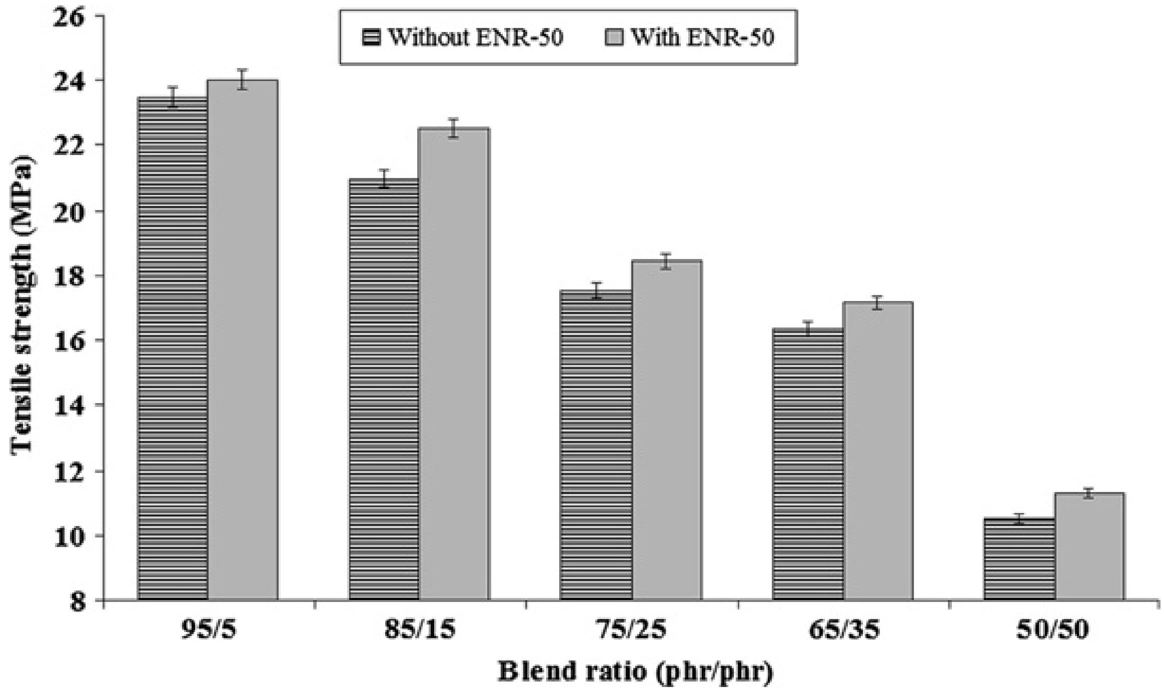

Figure 2.9: The tensile strength of SBR/NBRr with/without ENR-50 (Noriman et al., 2009).

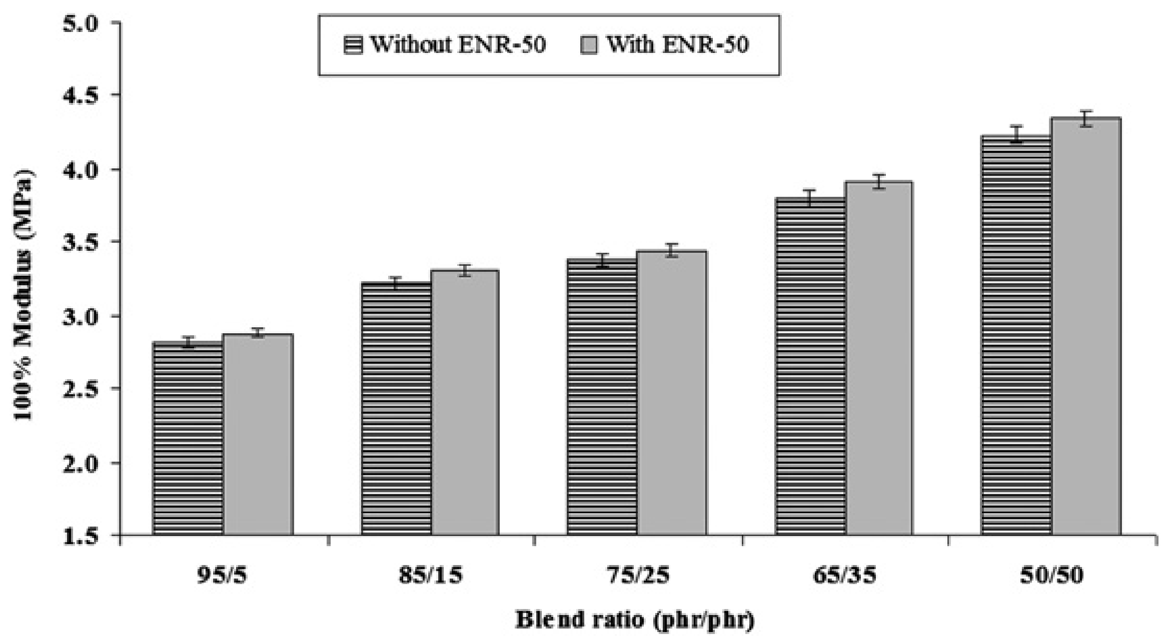

Figure 2.10: The tensile modulus of SBR/NBRr with/without ENR-50 (Noriman et al., 2009).