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College of materials Engineering

Department of Polymers and Petrochemical Industries

Project Title

studying the mechanical properties and making comparison of tire rubber before and after consumption

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Dedications

My university journey has come to an end after exhaustion and .hardship

And here I am, completing my graduation research with vigor and .energy

I am grateful to everyone who has contributed to my career

،And help me a little bit

Parents, family, friends, esteemed teachers…

I dedicate to you my graduation research…….

بسم الله الرحمن الرحيم

(قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ إِنَّمَا يَتَذَكَّرُ أُوْلُواالْأَلْبَابِ)

(الزمر: ٩)

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ABSTRACT

The aim of this research is to study the mechanical properties and compare the rubber tires before and after consumption. We used a new car tire and a used car tire (old), and we made three samples from each tire (Tensile strengh, Hardness, and wear). When we examined the samples with three tests (Tensile strengh, hardness and Wear), we found that the tire before use had a tensile value of(11Mpa) and a hardness value of(65), and the tire after use had a tensile value of(5Mpa) and a hardness value of(56.23), meaning that the tire after use has less Hardness and tensile strength and This is due to the breakage of the chains in the rubber due to friction and heat between the ground and the rubber. For the Wear test, the weight loss of the tire before use after half an hour on the weare machine is (0.0013g), and the weight loss of the tire after use after half an hour on the wear machine is(0.0012)g, so the weight loss of the samples is few because the rubber is supported by different fiber fiber.

Contents:

Chapter one

Introduction:

The first use of rubber was by the indigenous cultures of Mesoamerica. The earliest archeological evidence of the use of natural latex from the Hevea tree comes from the Olmec culture, in which rubber was first used for making balls for the Mesoamerican ballgame. Rubber was later used by the Maya and Aztec cultures – in addition to making balls, Aztecs used rubber for other purposes, such as making containers and to make textiles waterproof by impregnating them with the latex sap.

South America remained the main source of latex rubber used during much of the 19th century. The rubber trade was heavily controlled by business interests but no laws expressly prohibited the export of seeds or plants. In 1876, Henry Wickham smuggled red them to Kew Gardens, England. Only 2,400 of these 70,000 Amazonian rubber tree seeds from Brazil and delive and British Malaya. Malaya (now Peninsular Malaysia) was later to become the biggest producer of rubber. germinated. Seedlings were then sent to India, British Ceylon (Sri Lanka), Dutch East Indies (Indonesia), Singapore.

1.1 Rubber Properties:

Rubber exhibits unique physical and chemical properties. Rubber's stress–strain behavior exhibits the Mullins effect and the Payne effect and is often modeled as hyperelastic. Rubber strain crystallizes. Because there are weakened allylic C-H bonds in each repeat unit, natural rubber is susceptible to vulcanisation as well as being sensitive to ozone cracking. The two main solvents for rubber are turpentine and naphtha (petroleum). Because rubber does not dissolve easily, the material is finely divided by shredding prior to its immersion. An ammonia solution can be used to prevent the coagulation of raw latex. Rubber begins to melt at approximately 180 °C (356°F).

Vulcanization of rubber creates di- and polysulfide bonds between chains, which limits the degrees of freedom and results in chains that tighten more quickly for a given strain, thereby increasing the elastic force constant and making the rubber harder and less extensibe.

1.2 Types of Rubber:

1.2.1 Natural Rubber:

These are the elastomers which are obtained naturally. Natural rubber is made up of solid particles suspended in a milky white liquid (called latex) that drips from the bark of certain tropical and subtropical trees. This latex rubber is mainly found in countries like Brazil, India, Indonesia, Malaysia, and Sri Lanka. It is made by the polymerization of isoprene (2 methyl-1, 3-butadiene) which has a chemical formula (C5H8) n and it is known as cis- 1, 4-polyisoprene. In simple words, we can say that they are made by loosely joining the monomers of isoprene (C5H8) in the form of a long tangled chain.

1.2.2 Synthetic Rubber:

Synthetic rubbers are produced from petroleum and natural gas. It is obtained by polymerization of 1, 3 – butadiene derivatives or by copolymerization of 1, 3 – butadiene along with an unsaturated monomer.

Chapter Two

rubber casm ofing A tire is a strong, flexible attached to the ri a wheel. Tires provide a gripping surface for traction and serve as a cushion for the wheels of a moving vehicle. Tires are found on automobile s, trucks, buses, aircraft landing gear, tractors and other farm equipment, industrial vehicles such as forklifts, and common conveyances such as baby carriages, shopping carts, wheel chairs, bicycles, and motorcycles.

Tires for most vehicles are pneumatic; air is held under pressure inside the tire. Until recently, pneumatic tires had an inner tube to hold the air pressure, but now pneumatic tires are designed to form a pressure seal with the rim of the wheel.

2.1 Rew Material

Rubber is the main raw material used in manufacturing tires, and both natural and synthetic rubber are used. Natural rubber is found as a milky liquid in the bark of the rubber tree, Hevea Brasiliensis. To produce the raw rubber used in tire manufacturing, the liquid latex is mixed with acids that cause the rubber to solidify. Presses squeeze out excess water and form the rubber into sheets, and then the sheets are dried in tall smokehouses, pressed into enormous bales, and shipped to tire factories around the world. Synthetic rubber is produced from the polymers found in crude oil.

The other primary ingredient in tire rubber is carbon black. Carbon black is a fine, soft powder created when crude oil or natural gas is burned with a limited amount of oxygen, causing incomplete combustion and creating a large amount of fine soot. So much carbon black is required for manufacturing tires that rail cars transport it and huge silos store the carbon black at the tire factory until it is needed. Sulfur and other chemicals are also used in tires. Specific chemicals, when mixed with rubber and then heated, produce specific tire characteristics such as high friction (but low mileage) for a racing tire or high mileage (but lower friction) for a passenger car tire.

2.2 Tyre Manufacturing Process:

1. Rubber, fillers, antioxidants and other ingredients blended together to create a black, gummy compound that will be sent on for milling.

2. The compound of ingredients from step one is milled and then cooled, before being cut into strips to form the basic structure of the tyre itself. Other elements of the tyre are also prepared at this stage, such as the fabric cords and steel belts.

3. Using special machinery, the materials that make up the tyre are assembled into what is known as a ‘green tyre’. Starting from the inside, the casing is built first, followed by the tread, shoulder and sidewall. The tyre is now starting to look like the finished article.

4. Using hot moulds in a curing press, the green tyre is then vulcanised, compressing all the parts of the tyre together and giving the tyre its final shape. This includes its tread pattern and manufacturer’s sidewall markings. It is this process of curing which enhances the tyre’s flexibility and elasticity.

5. No tyre is finished without being inspected to meet Goodyear’s high standard. This is a task performed by trained inspectors using special machinery. Some tyres will also be pulled from the line to be checked by x-rays.

Chapter Three

Experimental Part

3.1 Vulcanization:

Vulcanization is a process of cross-linking rubber molecules chemically with organic/inorganic substance through the action of heat and pressure. The rubber which is cross linked chemically is known as vulcanizate The introduction of crosslinks into the rubber matrix may be comparatively few in number but are sufficient to prevent unrestricted flow of the whole molecules past neighboring ones. The low concentration of crosslinks implies that the vast majority of the segments making up the long chain molecules are free to move by virtue of kinetic energy. An unvulcanized rubber dissolves completely in its solvent. In contrast, a vulcanized rubber only swells. The chemical crosslinks prevent complete dissolution. A vulcanized rubber in this sense is a solid and will retain its shape and dimensions. Vulcanization is a very important process in the rubber industry and conducted at relatively high temperatures (140–200 °C For latex dipped goods, vulcanization is conducted at relatively low temperatures (60–120 °C) and requires no pressure as the latex is in fluid form and flows to take the final shape of the former and mold.

One of the most important chemicals in vulcanization is the cross linking agent. Elemental sulfur is the most widely used cross linking agent in the rubber industry because it is very cheap, abundant, and easily available. Besides, sulfur is very easy to mix and readily soluble in the rubber. By varying the amount of sulfur to the accelerator ratio one can get different types of crosslink in the rubber matrix. Table 7 summarizes the types of sulfur vulcanization system,15 nature of crosslinks produced and their influence on technological properties. Thus sulfur vulcanization provides flexibility as one can control the type of crosslink intended for specific use or applications. The most basic requirement bonds on the rubber hydrocarbon. The nonsulfur cross-linking agents include organic peroxides, quinines and their oximes and imines, metallic oxides, and high energy radiation.

Laboratory Tests

This section gives all tests to the rubber material for the purpose of making a rubber spout According to ASTM standard.

3.2.1 Tensile Test:

Sample Preparation steps:

1. Measure the length(45mm), width(5.3mm), and thickness(2,5) of the sample in figure (3-1) before conducting the test.

2. The sample is installed in the general test device shown in Figure (3-2) and the device is calibrated before conducting the test.

3. The force in (kN) is applied to the test form by hydraulic method and gradually, and readings are taken and recorded.The force applied to each elongation.

4. The download process continues until the model fails and is interrupted, then the model is removed from the device and measurements are taken After the failure.

Figure(3-1)Dumbbell specimen

Figure(3-2)Tensile test

3.2.2 Hardness Test:

International Hardness Testing one of the most important measurements of solid ball penetration in a rubber sample is in certain conditions where the test is performed according to ASTM-2240 standard using (Shore A) endurance scale figure (3-3), where the hardness gauge is used directly through the needle surface to measure the rigidity. Each sample has(5) readings to verify the accuracy of the test.

Sample Preparation Steps:

1.We brought two samples of a new tire and an old tire, and we made samples as shown in figure (3-4).

2.Then we examined the two samples with the hardness device and recorded the following readings Tire before use (63.7, 71, 60.3) Tire after use (60.1, 53.8, 54,8) Then we calculated the mean for both samples.

Figure(3.3) Hardness(shor A)(Tet Equipment)

Figure(3-4)Show the Sample of Hardness Test

3.3.2 Wear Test:

As shown in Figure (3-5)ASTM G99, the sliding test was conducted in the pin-on-disk wear device. Under dry (unlubricated) circumstances, wear samples were screened. The size of the pin specimen (5 cm long, 6 mm in diameter). For all tests, the counterface was made of steel carbide with 0.1 μm roughness , 57HRc hardness and 35 mm diameter. The experiments were conducted under environmental circumstances.

Procedure of pin-on-Disc Test

1.Immediately prior to testing, and prior to measuring or weighing, clean and dry the rubber specimens. The metallic disc was cleaned with alcohol in order to remove any possible traces of oil, grease and other surface contaminants. The rubber specimen was also cleaned with ethanol.

2.Weight the specimens to the nearest 0.0001 g.

3.Insert the metallic disc securely in the holding device so that the disc is fixed.

4.Inserting the rubber pin specimen securely in its holder

5.Adding the proper mass to the system lever to develop the selected force pressing the pin against the disc.

6.Setting the revolution counter to the desired number of revolutions.

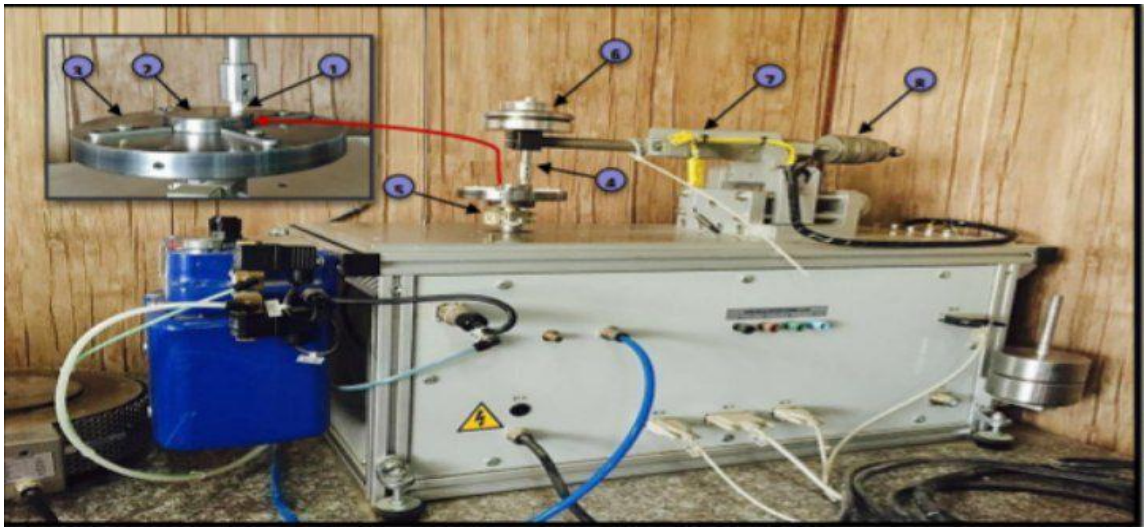
7.The test is stopped when the desired number of revolutions is achieved.

8.Removing the specimens and clean off any loose wear debris.

9. Reweighing the specimens to the nearest 0.0001 g.

10.Repeating the test with rubber with (0, 0.2 ,0.6 ,0.8 ,1 , and 1.2) wt. % ZnO.

11.Determining the wear volume from equation wear.



Figure(3-5) pin-on-Disc sliding machine.

Table:Device Element

No.	Description	No.	Description
1	Pin specimen	5	Emergency stop
2	Disk specimen	6	Applied load
3	Disc holder	7	Load cell
4	Pin holder	8	Balance weight

Chapter Foure

Results:

Tire rubber befor and after consumption

4-1 Tensile Test result:

when we examined the samples (tire befor consumption, tire after consumption) in this test ,We found two reading in row(11,5Mpa) the highest value is tire before consumption.Due to the breaking of the bonds as a result of the heat, the friction between the ground and the tire, the tensile strength decreases. According to the following drawing.

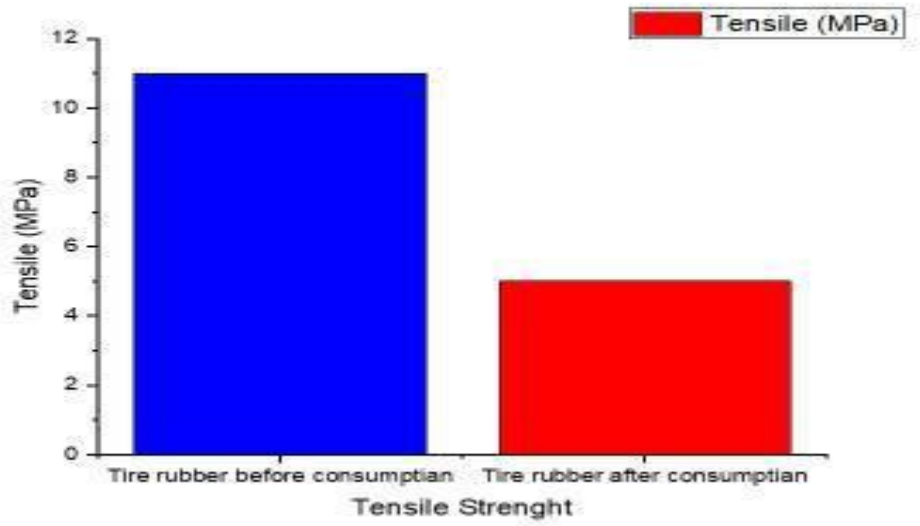


Figure (4-6) Tire tensile test before and after consumption

4-2 Hardness Test result:

when we examined the samples (tire befor consumption, tire after consumption) in this test ,We found two reading in row(65,56.23) the highest value is tire before consumption.Because of the friction between the ground and the rubber, the hardness decreases. According to the following drawing.

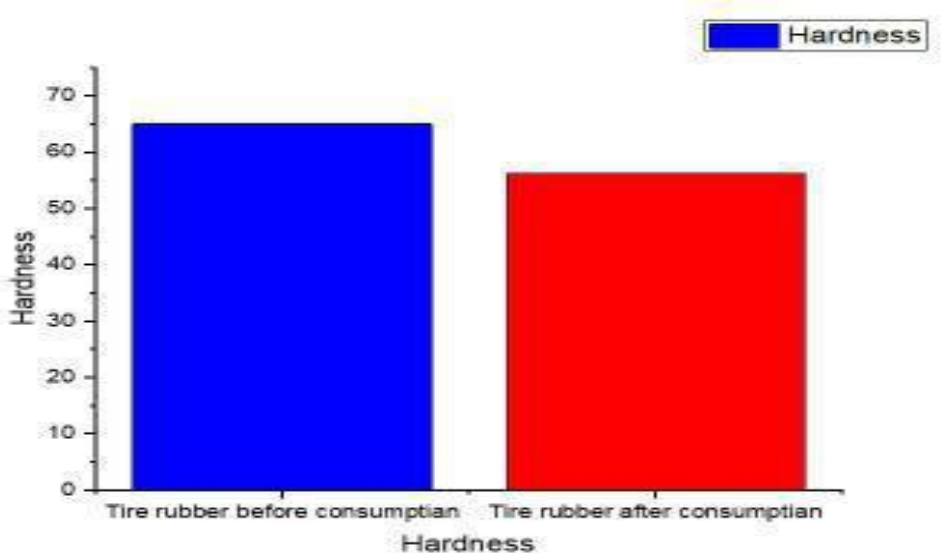


Figure (4-7) Tire hardness test before and after consumption.

4-3 Wear Test result:

when we examined the samples (tire befor consumption, tire after consumption) in this test ,We found two reading in row(0.0013,0,0012g).There was no significant loss in weight because the rubber was reinforced with multiple fibers. According to the following drawing.

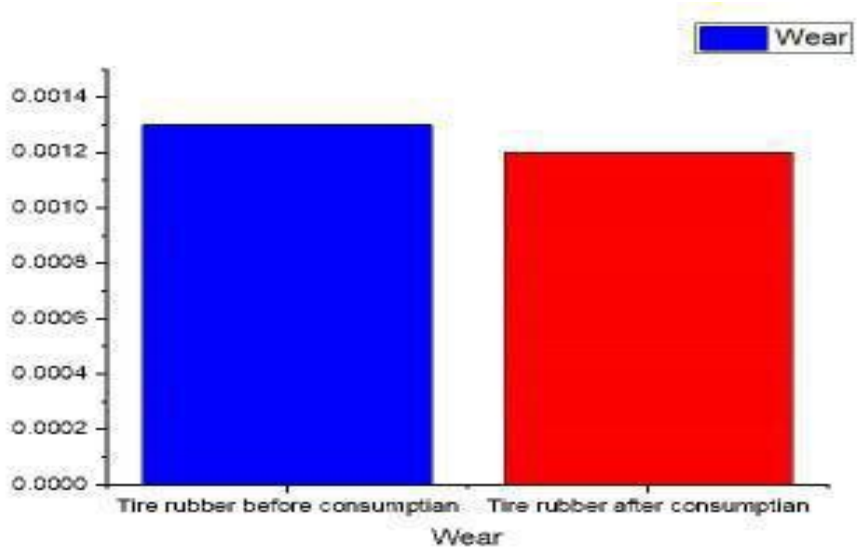


Figure (4-8) Tire wear test before and after consumption.

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