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Comparative Studies of Natural and Synthetic Rubber.

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ABSTRACT

A comparative study of natural and synthetic rubber has been carried out .In the present work small scale production of Thiokol rubber and also natural rubber is planned. Thiokol rubber is produced by the condensation polymerization of sodium polysulfide and ethylene dichloride. This Thiokol rubber is rather strong when compared to the natural rubber and synthetic natural rubber (vulcanized).Various tests like hardness test, abrasion test, compression test, accelerate ageing test has been carried out to compare the characteristics of natural and synthetic rubber.

Keywords: Thiokol, Synthetic, Polymerization, abrasion, compression

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INTRODUCTION

Natural rubber is an elastic hydrocarbon polymer that naturally occurs as a milky colloidal suspension, or latex, in the sap of some plants. It is used extensively in many applications and products. The use of rubber is widespread, ranging from household to industrial products, entering the production stream at the intermediate stage or as final products. Tires and tubes are the largest consumers of rubber, accounting for around 56% total consumption in 2005. The remaining 44% are taken up by the general rubber goods (GRG) sector, which includes all products except tires and tubes.Other significant uses of rubber are door and window profiles, hoses, belts, matting, flooring and dampeners (anti-vibration mounts) for the automotive industry in what is known as the "under the bonnet" products [1-11].

Synthetic rubber is any type of artificially made polymer material which acts as an elastomer. Synthetic rubber can be made from the polymerization of a variety of monomers including isoprene (2-methyl-1, 3-butadiene), 1, 3-butadiene, chloroprene (2-chloro-1, 3-butadiene), and isobutylene (methyl propene) with a small percentage of isoprene for cross-linking.

MATERIALS AND APPARATUS

- Sodium hydroxide solution,
- 1M Sulfur
- 1, 2-dichloroethane
- Distilled or deionized water
- Copper wire, approximately 6 inches long (15 cm)
- 2 10-Ml vials with Teflon cap liners
- 2 400-Ml beakers
- 10 Ml graduated cylinder
- Glass pipette (dropper)
- Chemical resistant gloves

EXPERIMENTAL PROCEDURE

Water bath is prepared by filling a 400-Ml beaker with approximately 350-Ml of deionized water. Beaker is placed on a hotplate and water is allowed to boil. 0.5 g of sulfur is weighed and is added to the vial. 5 Ml of 1 M sodium hydroxide is added to the vial. Vial is tightly sealed and the reaction mixture is shaked well. Copper wire is wraped around the vial leaving several inches to serve as a handle.Vial is placed in the boiling water and is heated for about 3 minutes. Vial is removed from the water and is inverted several times to mix the contents, and then place it back into the boiling water. This process is repeated once again and the contents should turn red during this heating. Then vial is removed from the boiling water and is allowed to cool for few minutes. The apparatus is moved to a fume hood. Working under the hood, vial is removed from the cold water. The copper wire handle is removed and the cap is removed and the red solution is decanted only into a clean vial, leaving any solid behind in the first vial. The first vial is resealed and is placed in the waste bucket under the waste hood.1 Ml of 1, 2-dichloroethane is added to the red sodium polysulfide solution using a glass dropper in the second vial. It is tightly sealed and the wire handle is reattached. The reaction mixture is shaked vigorously and is placed back into the boiling water bath.

NOTE: If any bubbles begin to flow out of the vial cap during the reaction, the vial is removed from the water, allowed to cool, and the cap is tightened.

After about 3 minutes of heating, the vial is removed from the boiling water and is inverted several times to mix the contents, and then placed back into the boiling water. The vial is heated for 20 minutes and is removed every 5 minutes and is inverted several times to mix the contents and replaced into the boiling water. During this time a rubbery lump of yellow Thiokol will begin to form. After 20 minutes, the vial is removed from the hot water and is allowed to cool for a few minutes. The vial is placed in a beaker of cold water for two minutes. Working under the hood, the vial is removed from the cold water.The copper wire handle and the cap are removed. Any liquid in the vial is poured into a waste bottle in the waste hood, keeping the Thiokol product in the vial.

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PREPARATION OF A RUBBER BALL FROM RUBBER LATEX

MATERIALS AND APPARATUS

- Two paper cups (5 ounce)
- Stirring rod (Popsicle stick or equivalent)
- Small bucket or large beaker
- (1000 mL or larger)
- 15 mL rubber latex
- 15 mL vinegar
- 15 mL water

EXPERIMENTAL PROCEDURE

15 mL of latex and 15 mL of vinegar is measured and is taken into two paper cups. A glass rod is taken and is dipped in the latex solution and vinegar and then again in the latex solution. We can observe the rubber solidifying and forming into solid rubber. Now mix the two solutions and stir it until hard mass of rubber is obtained. Then it is squeezed and dried and finally the weight is measured.

TESTS PERFORMED AND RESULTS

ROCKWELL HARDNESS TEST

The Rockwell hardness test method consists of indenting the test specimen with indenter. The indenter is forced into the test sample under a preliminary minor load for usually 10kgf. when equilibrium is reached an indenting device which follows the momentum of the indenter and is set to applied with resulting increase in penetration when equilibrium is again attained the additional major is removed allows a partial recovery so reducing the depth of penetration. The permanent increase in depth of penetration resulting from the application and removal of the additional major load is used to calculate the Rockwell hardness number.

$$HR=E-e$$

Fo = preliminary minor load
F1 = additional major load in Kgf.
F = total load in Kgf
e = permanent increase in depth of penetration due to major load.
E = a constant, depending on form of indenter
(100 units for diamond indenter)
HR =Rock well hardness number.
D = diameter of the ball.

PROCEDURE

The lever is kept at normal position and the indenter is fixed and the screw is tightened. The major load is set by turning the load selector wheel .Given specimen is placed on supporting table and the hand wheel is turned. The supporting table is moved till the small point reaches the red dot on the dial which indicates application of minor load on the specimen. Now major load is applied by slowly changing the position of hand lever from normal position to load position. Load is kept for 10 to 15 seconds and the major load is removed by slowly bringing the lever to normal position.

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RESULTS

Table 1

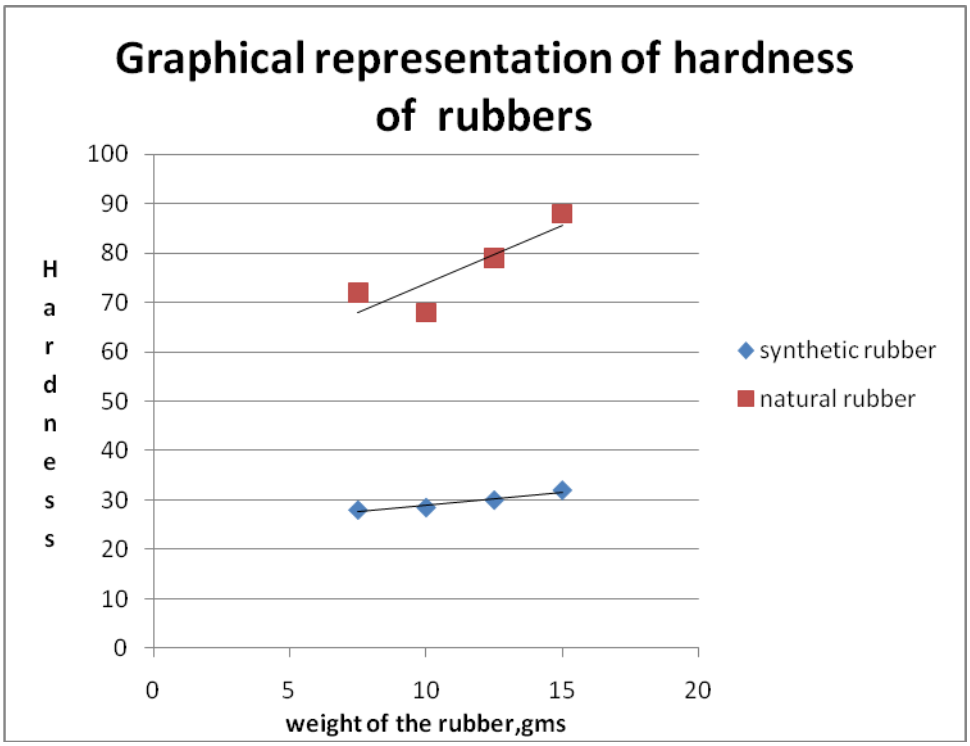
s.no	hardness
1.	15
2.	12
3.	10
4.	20
5.	15
6.	16
7	41
average	18.42

Value of hardness for:
Thiokol specimen is 18.42

s.no	hardness
1.	74
2.	97
3.	9
4.	10
5.	65
6.	45
7	56
average	50.8

Value of hardness for:
Natural rubbers is 50.8

Graphical representation of hardness of rubbers



ABRASION TEST

Abrasion resistance may be defined as the resistance of the rubber vulcanized to wearing away by rubbing or impact during service. The principle involved in the test is to rub the test sample against standard rough surface, such the sandpaper for a specified time. The loss due to this rubbing is then calculated and expressed as loss in weight. This test is used to determine whether the given sample is resistant to wear and tear for a long time. This test is performed in case of the rubber when it is used in manufacture of shoes, vehicle tires etc.

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RESULT:

Table 2

Type of rubber	Initial weight (gms)	Final weight (gms)	Time for abbrasion
Thiokol	15.250	14.70	120 seconds
Natural	3.830	3.290	120 seconds

COMPRESSION TEST

Compression set in rubber may be defined as the amount (percent) by which a standard test piece fails to return to its original thickness after being subjected to a standard compressive load or deflection for a specified period of time. Whether the testing is done under constant stress or strain, in involves compressing of the test specimen between two parallel plates and keeping it in that position for a specified period at a particular temperature. After the specified time, it is taken out and kept at room temperature for half an hour. The thickness of the sample is then measured and compression set calculated. For products like oil seals, gaskets, engine mounts, bridge bearings etc. the set value should be very low. Usually high loading of reinforcing fillers and under curing of the compound give high set values.

RESULT:

Compression test is performed by keeping rubber sample under a load of 70 kgf for a period of 300 seconds.

Type of rubber	Initial thickness	Final thickness	Time of compression
Natural	70 mm	40 mm	300 seconds
Thiokol	80mm	60 mm	300 seconds

ACCELERATE AGEING TEST

The natural deterioration of the Vulcanized under the action of heat, light, oxygen, ozone etc. is termed as 'ageing'. The service life of a product is too long to wait for getting information regarding the performance of the product under the influence of the above mentioned agents. It is therefore necessary to test the Product, under conditions which can produce accelerated ageing effects, to get some idea of the service life and performance of the products. Accelerated ageing tests magnify the influence of one or more of the above agents which affect the service life of the products. The testing is done usually, by keeping the test samples under the influence of temperature, oxygen or ozone for a specified period and then determining the physical properties like tensile strength or noting the visual appeal. The fall in properties from the initial value or the change in appearance gives an indication of the resistance of the rubber vulcanized to that particular factor. Apparatus like hot air ovens, oxygen bomb, ozone chamber etc. are used for performing the accelerated ageing. Here the hot air oven is used at a temperature of 60C for 30 min and the properties like tensile test and water repellence are determined.

RESULT:

Type of rubber	Initial hardness	Final hardness	Type of ageing
Natural	50.8	32.3	Hot air oven
Thiokol	18.42	18.3	Hot air oven

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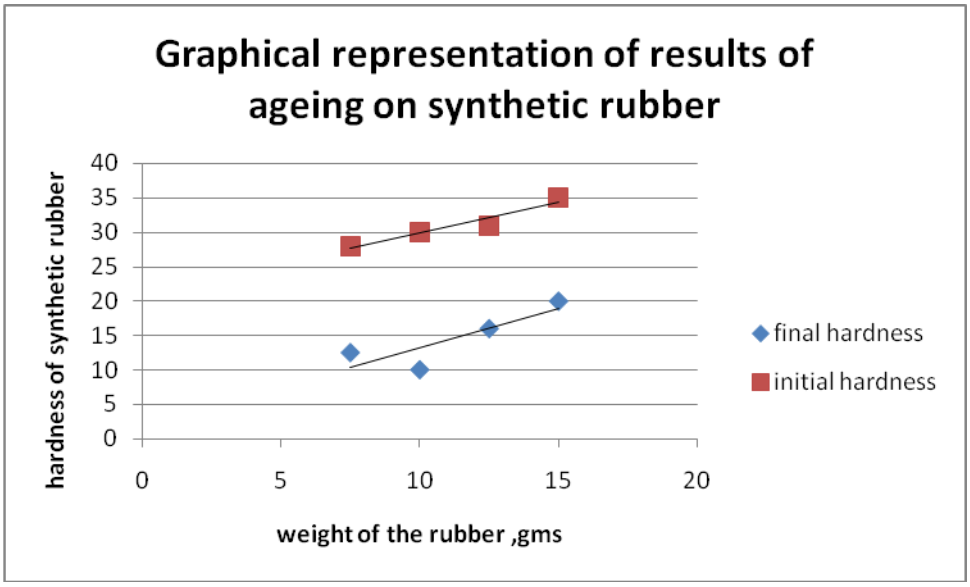

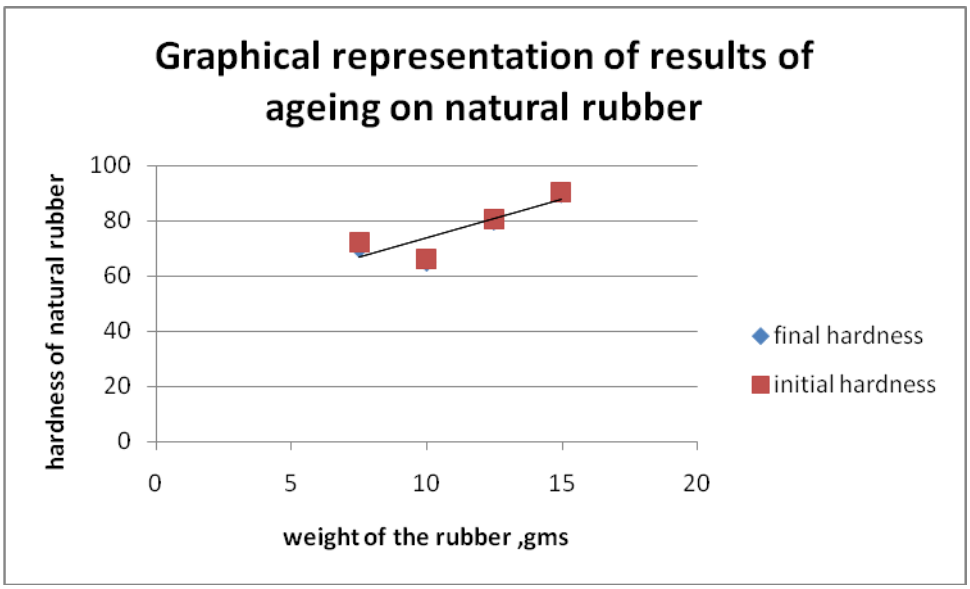

Cost estimation for the project:

S.NO	KEY INGREDIENTS	QUANTITY	COST (Rs)
1.	NaoH	500gms	120/-
2.	DISTILLED WATER	500ml	60/-
3.	SULFUR	500gms	300/-
4.	DICHLOROETHANE	500ml	250/-
5.	VINEGAR	500ml	15/-
6.	RUBBER LATEX	500ml	600/-

SYNTHETIC RUBBER

For producing 20 gms of Thiokol rubber:

NaoH……8 gms…… Rs2/-

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Distilled water……..200ml…….....Rs 24/-
Sulfur……25gms…… Rs 15/-
Dichloro ethane……50ml…….. Rs 25/-

NATURAL RUBBER

For produciong 20 gms of natural rubber:

Rubber latex……..15ml…….. Rs 18/-
Vinegar……15ml…….. Rs 1/-

Total cost of the raw materials for producing 20 gms of Thiokol and 20 gms of natural rubber for the project is…….. Rs 85/-

CONCLUSIONS

Thiokol rubber is the one which is produced by the condensation polymerization of sodium polysulfide and ethylene dichloride. This Thiokol rubber is rather strong when compared to the natural rubber (crude) and synthetic natural rubber (vulcanized).This result is obtained by studying various physical properties of rubber and comparing those properties by performing the tests like Hardness test, Abrasion test, Compression test, Accelerate ageing test. By observing the results obtained from various tests it is determined that natural rubber is having certain typical properties which can be further improved by vulcanization. Where as in Thiokol rubber it is already prepared by adding additives, so, the scope of improvising is quite low in this case. And here we are concluding that the synthetic rubber even though holding many advantages in applications compared to natural rubber it is beneficial to use natural rubber (vulcanized) where we can get more special and improved properties than Thiokol rubber.

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