International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume: 3 | Issue: 4 | May-Jun 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 - 6470

Analogy of Some Physicomechanical Properties for Rubber Cement

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How to cite this paper: Dr. Htoon Nay Oo "Analogy of Some Physicomechanical Properties for Rubber Cement" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-4, June 2019, pp.1457-1460, URL: https://www.ijtsrd.com/papers/ijtsrd25103.pdf

IJTSRD25103

ABSTRACT

The research is aimed to characterize and apply the rubber cement. The physicomechanical properties of rubber cement such as tensile strength, elongation at break, waste uptake and compression percent were determined by standard rubber testing. Tensile strength of 28 to 32 kg/cm2, elongation at break of 580 to 630 %, water uptake (24 hours) of 8 to 10% and compression percent of 80 to 85 % were obtained. Determination of swelling parameters of rubber cements was carried out with respect to selected oil (gasoline). The manufacture of products from recycled materials has technologic, economic, and environmental advantages that have become attractive in recent years. The ever increasing amount of waste rubber from disposal of used tires has grown into a serious environmental problem around the world.

Keywords: *rubber cement; swelling; tensile strength; elongation; compression percent*

1. Introduction:

The cement production industry is an important consumer of carbon-based fuels as a source of heat, releasing huge amounts of CO_2, which is the major greenhouse gas responsible for global warming.

In a previous work, the addition of 10% of powdered tire rubber (35 mesh maximum size) inordinary Portland cement pastes was investigated. This rubber was used untreated and after surface-treatment with NaOH saturated aqueous solution.

So, in a number of countries slag cements are replacing ordinary Portland cement. Slag content varies from country to country as slag composition depends on the location of each iron-making industrial unit. Composition differences will reflect in the properties of the resulting slag-modified cements.

The bonds in cementations materials must result from some combination of mechanical interlock, Vander Waals forces, hydrogen bonds, and even chemical reactions. The presence of polar interactions, for example, a polymer containing groups capable of significant hydrogen bonding or acid-base interactions will improve significantly the capacity of adhesive joint formation.

Strength is commonly specified property for cement-based materials. This property depends not only on the characteristics and proportions of the components of cementations materials, but also on the mechanism of failure. The interfacial region is often considered to be the weakest part of cement-based materials and the preferential route for the penetration of water or aggressive species from the environment. The interface thus is critical for determining durability of cement-based materials [3].

Rest of the paper is organized as follows. Related components are highlighted in Section II. The proposed system is in Section III. The results and discussion are in Section IV. The conclusions of the present work are in Section V.

2. Related Components

In this section, the research focuses on the rubber cement as well as natural rubber, synthetic rubber and how applies Tire Plug Kit and how to create the Procedure for uses of rubber cement.

2.1 Natural Rubber

NR, or Natural Rubber sometimes called “india rubber” is a visco-elastic material consisting of a natural organic compound called polyiso-preme as well as, other organic compounds including water. This material is an elastic polymer or elastomer derived from natural latex from certain plants and trees. Natural rubber has an excellent and long flex life with high tensile strength and can come in a wide range of hardness for various applications. Despite its extreme flexibility and stretchable properties it is subject to weathering and has a poor resistance to heat oil and ozone despite being generally waterproof [2].

2.2 Synthetic Rubber

A synthetic rubber is any artificial elastomer. These are mainly polymers synthesized from petroleum by products. About fifteen billion kilograms (thirty-three billion pounds) of rubbers are produced annually, and of that amount two thirds are synthetic. Global revenues generated with synthetic rubbers are likely to rise to approximately US$56 billion in 2020. Synthetic rubber, like natural rubbers has uses in the automotive industry for tires, door and window profiles, hoses, belts, matting, and flooring [2].

2.2.1 Nitrite Butadiene Rubber(NBR)
Nitrite butadiene rubber is a family of synthetic rubber copolymers derived from 2-Propenentrile and various butadiene monomers. The physical properties of each specific family member varies but these forms of synthetic rubbers are generally resistant to attack from oils, minerals, fuels and solvent and offers a fair resistance to heat and aging. The varying ratio of nitrile within the polymer can change the characteristics. The more nitrile used the higher it's resistance to oil but flexibility of the material suffers. NBR is used throughout a wide range of industries and in the manufacture of countless products [4].

2.2.2 Silicon rubber
Silicon Rubber is an elastomer that is composed of silicone, carbon, hydrogen and oxygen. These rubbers are often one or two-part polymers based and are generally stable and non-reactive with good resistance to extreme environments and temperatures from -55^{0}C to +300^{0}C while still retaining useful properties. This material has a broad range of uses because of this stability to be easily shaped and formed into application specific designs. Depending on the end use heat or vulcanization may be required to cure the silicone into its final rubber form.

2.2.3 Styrene-Butadiene rubber
SBR or Styrene-butadiene rubber is a family of synthetic rubbers derived from styrene and butadiene. These rubbers have good abrasion resistance and good stability with aging over time when protected by additives. The ratios of styrene/ butadiene change the properties of the material. Higher levels of styrene are less elastic and flexible than other versions [1].

2.3 Use of Tire Plug Kit (Rubber Cement)
Tires are made of rubber and therefore can be punctured, there it little anyone can do to prevent this. We can however be prepared to face this eventuality. Everyone should have a spare tire, a can of "Fix-A-Flat" type emergency sealant and a tire plug kit in their vehicle, especially if it is your BOV. Using a plug kit (Rubber Cements) one can easily make a basically permanent repair to their tire in the field.

Using a plug kit generally requires that you have access to compressed air in order to re-inflate your tire once it has been plugged; portable 12V compressors are handy for this. If you have side wall damage then go straight to the spare and take the tire to a repair shop to been evaluated. The side wall of a tire is much weaker than the tread and often times will not properly hold a plug. Only use the channel "Fix-A-Flat" type repair in an emergency when you cannot or do not feel safe trying another repair method, the material in the can is generally flammable and messy to remove.

The plug can be applied to the tire while it is mounted on the vehicle if you are able to reach the damage area, stabilize the vehicle with your jack first since the tire will be losing air pressure (this can be dangerous). I recommend you remove the tire for the repair, this will make the damage easier to get to and therefore more likely you will apply the plug correctly and it is safer [5].

2.4 Procedure for uses of rubber cement
1. The first step is to locate the following foreign object in your tire.
2. Remove the object.
3. Put 2-3 drops of the rubber cement on the tip of the probe and insert the probe into the puncture. Work the probe in and out while twisting to clean and prep the puncture and apply the cement. This process will also enlarge the hole to that the plug will fit through; because of this the first couple of insertions can be difficult. Repeat this process 2-3 times to make sure the puncture is clean and that there is enough cement in the wound.
4. Take each end of the repair strip, this is the plug, and roll the center of the strip into the needle eye. Apply 2-3 drops of rubber cement to the end of the needle and push the needle into the puncture leaving about ¼ inch above the surface of tire. The needles can the difficult to push through depending on the size of the puncture.
5. Twist the handle ¼ turn and pull the needle out of the tire, the plug should not come out with the needle. Now cut the remaining plug down to about 1/8 of an inch. The tire should be drivable almost immediately. I have used many plugs and never had a problem with them leaking or coming out of the tire. The manufacture of the kit recommends that you have the tire inspected by a professional afterwards, but I consider the plugs permanent. Be sure to air the tire back up to recommended specs and if you have removed the wheel be sure to properly torque the lugs nuts after your reinstall it.

3. Proposed System
In this section, the research emphasizes on the reclaimed rubber how to get the reclaimed rubber powder. Secondly, preparation of rubber cement happens how to mix the natural rubber, reclaimed rubber and nitrile butadiene rubber and other materials such as equipment.

3.1 Reclaimed Rubber
Vehicle tyre waste (no more used as vehicle tyre) was cut with different types of cutting machines to obtain rubber belts. Then, those belts were chipped with chipping machine. The rubber chips were ground in the grinding mill to obtain reclaimed rubber powder. The block diagram of this procedure is shown in Figure (1).

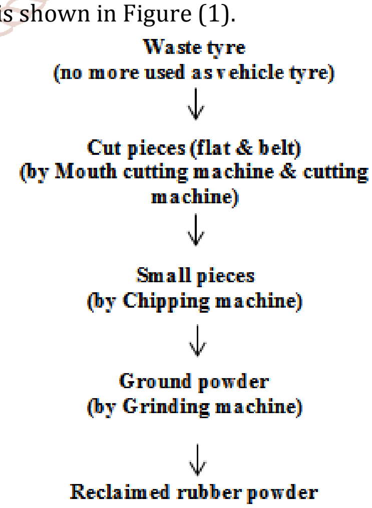

Figure1. Schematic diagram of preparation of reclaimed rubber

3.2 Rubber cement
Proportions of the weights of the used chemicals are shown in Table (1). Natural rubber smoked sheet nitrile butadiene rubber and reclaimed rubber were first rolled about 5 min by a roller to break out the fibrous bond of rubber polymer chain. This process is called mastication.

Table1. Composition of prepared Rubber cement

Ingredient	Rubber Cement (Parts by weight)
Natural rubber(NR)	75
Reclaimed rubber(RR)	25
Nitrile butadiene rubber	25
Zinc oxide	3
Stearic acid	2
Mercapto benzothiazole(MBT)	2
Precipitated calcium carbonate	40
Clay	20
Solvents(hexane,heptane,octane)	60
Alcohol/Acetone	20

The mercaptobenzothiazole (MBT) was added and rolled about 30 min. Steric acid, zinc oxide were added simultaneously and continuously rolled about 4 min. Then precipitated calcium carbonate (PCC) and clay were added in order to make the vulcanite harder and to develop resistant. It was then rolled mixing time was approximately 20 min. During the mixing, water was passed through the roller to control the generated heat. The flow diagram of preparation of rubber cement is shown in Figure (2).

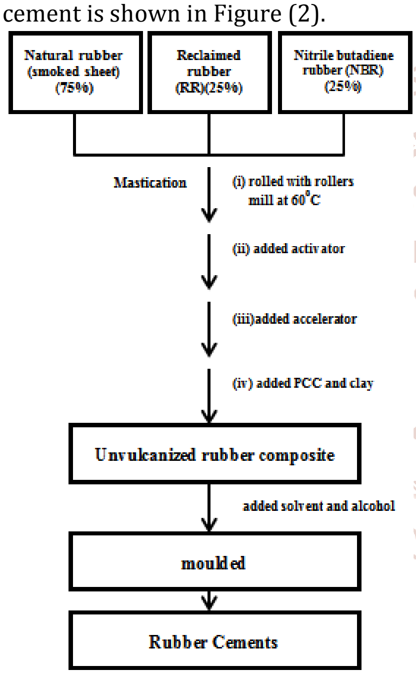

Figure2. Schematic diagram for preparation of rubber cement

3.3 Equipments

All chemicals used in this research were procured from British Drug House (BDH), England. The chemicals were used as received unless stated otherwise. All specific chemicals used were cited detail in each experimental section. The apparatus consist of conventional lab ware, glass ware and modern equipment; they are cited in each experiment. The following were some of the instruments used in the experiments in this research.

Tensile Testing Machine
-Houns Field 5000E, England

Wallace Direct Reading Specific Gravity Balance
-Wallance Co.,Ltd, England

Roller
-H.W. Wallace & Co.,Ltd, England

Microbalance
-Balance Sartorius AG Gottingen, BL 2105, Switzerland

Sankyo Testing Sieve
-Sankyo Special Eire Netting Co.,Ltd, Osaka, Japan.

3.4 Sampling

Rubber cement sample I (King's power brand), sample II (Kexcondotti brand) and sample III (Quick-seal brand) were collected from commercial market in Yangon.

3.5 Physicomechanical Properties of Rubber Cement Samples

In this section, the research determines the tensile strength and elongation at break, compression set materials, water uptake percent of rubber cements and swelling percent of rubber cements.

3.5.1 Determination of tensile strength and elongation at break

Materials

Rubber cement sample I, II, III, IV

Apparatus and Equipments

Tensile strength testing machine (Hounsfield 5000 E, England), cutter (Wallace)

The tensile strength and elongation was calculated as described as follow:

$$Elongation at break(\%) = \frac{L_1 - L_0}{L_0} \times 100 \quad (1)$$

Where, L_o= the initial test length in millimeter
L_1= the test length at break in millimeter

Procedure

The rubber cement composite sheets were cut off according to JIS 7127. The both ends of the test pieces were firmly clamped in the jaw of tensile testing machine. One jaw was fixed and other was movable. The movable jaw was moved at the rate of 10 mm/min. The resultant data were shown at the recorder. This procedure was repeated for three times for each result. The results are presented in Table (2).

3.5.2 Determination of compression set

Materials

Rubber cement sample I, II, III, IV

Apparatus and Equipment

Compression set tester

The compression set was calculated as described as follow:

$$Compression percent(\%) = \frac{A-B}{A} \times 100 \quad (2)$$

Where, A= original thickness
B= final thickness after compression

Procedure

A moulded cylinder of rubber, used as the specimen which may be compressed at normal or elevated temperature to a pre-determined (in term of percentage) height, is measured after compressing for a period of 24 hr. The results are presented in Table (2).

3.5.3 Determination of water uptake percent of rubber cements

Materials

Rubber cement sample I, II, III, IV

Apparatus and Equipment

Glass bottles with screw-tight metal cap (100 mL), balance (Sortorium AG Gotingen B1-2105).

Procedure
The test piece with uniform thickness and volume were used. The test pieces were weighed to the nearest milligram and then the initial weight of all pieces were nearly the same before water uptake.

Each piece was placed in each screw-tight metal capped test bottles (100mL) containing 50mL of water at room temperature. The test piece was taken off from the bottle and blotted with filter paper to remove adhere water on surface and weighed the sample. The weight gain was measured during 24 hours. The results are presented in Table (2).

3.5.4 Determination of swelling percent of rubber cements

Materials
Rubber cement sample I, II, III, IV
Gasoline

Apparatus and Equipment
Glass bottles with screw-tight metal cap (100 mL), balance (Sortorium AG Gotingen B1-2105).

The swelling percent of rubber cement was calculated as described as follow:

$$Swelling\,percent(\%) = \frac{W_S - W_d}{W_d} \times 100 \quad (3)$$

Where,
W_s= combined weight in gram of sample and oil absorbed at a given time
W_d= weight in gram of sample at the dry state

Procedure
The test piece with uniform thickness and volume were used. The test pieces were weighed to the nearest milligram and then the initial weight of all pieces were nearly the same before swelling.

Each piece was placed in each screw-tight metal capped test bottles (100mL) containing 50mL of the selected solvent such as gasoline, at room temperature. The test piece was taken off from the bottle and blotted with filter paper to remove adhere water on surface and weighed the sample. The weight gain was measured during 3, 6 and 9 days. The results are presented in Table (2).

4. RESULTS AND DISCUSSION

The focus of this research was to investigate the effect of Rubber Cements. The investigation was done on different samples of rubber cements. The comparisons of the physicochemical properties of rubber cement samples were also performed.

4.1 Physicomechanical properties of rubber cement samples

The physicochemical properties (tensile strength, elongation at break, water uptake and compression percent) were measured and the resultant data are summarized in Table (2). It was found that the tensile strengths of sample I, II, III and IV were 30, 29, 32 and 28 MPa, elongation at break were 610% (sample I), 590% (sample II), 630% (sample III) and 580% (sample IV). Compression percent's of all samples were nearly the same (~80%). Water uptake percent of all samples were not significantly distinct. Among the four brands of rubber cement, sample II and IV are nearly the value of properties in the tensile strength and elongation at break as shown in Table (2).

Table2. Physicomechanical Properties of Rubber Cements

Properties	Rubber Cements			
	I	II	III	IV
Tensile strength (MPa)	30	29	32	28
Elongation at break (%)	610	590	630	580
Water uptake (%)	8	10	9	10
Compression (%)	83	80	85	80

Where, Sample I — King's Power Brand
Sample II — Kexcondotti Brand
Sample III — Quick-seal Brand
Sample IV — Prepared rubber cement

4.2 The swelling properties of rubber cements

Table (3) shows the results of swelling of rubber cement samples in selected solvent (gasoline) at different time intervals. The rubber cements can absorb the highest amount of gasoline without damage during 3 days. After that 6 days and 9 days of swelling duration, rubber cements I and II can absorb a little amount of gasoline than 3 days but sample III was dissolution in gasoline.

Table3. Weight Changes of Rubber Cements in Gasoline at Different Time Intervals

Rubber Cements	Initial weight (g)	Final weight (g)		
		3 days	6 days	9 days
Sample(I)	0.787	2.3	2.33	2.34
Sample(II)	0.488	1.4	1.43	1.45
Sample(III)	0.596	2.4	2.37	2.36
Sample(IV)	0.781	2.4	2.5	2.5

5. CONCLUSIONS

The results of investigation have been shown the durable and flexible of rubber cements. It was found that the highest that tensile strength and elongation at break were observed in sample III. Among the four brands of rubber cement, sample II and IV are nearly the value of properties in the tensile strength and elongation at break. Using a plug kit (Rubber Cement) one can easily make a basically permanent repair to their tire in the field.

6. ACKNOWLEDGMENTS

I would like to express my deepest gratitude to Professor & Head, Dr.Cho Cho Win, Department of Chemistry, Dagon University, for her kind guidance. I wish to thank my parents and all persons who directly and indirectly contributed towards the completeness of this research.

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