REINFORCEMENT OF NATURAL RUBBER BY USING HUMAN HAIR

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ABSTRACT

The present study concerns the studies on the use of keratin waste, derived from Human Hair as short fiber for elastomer. The aim of this study is improve reinforcement of natural rubber by using. Human hair is cheap material and it's give good strength. Human hair has slow decomposition. Slow decomposition of hair improves service life of composite. The composite is prepared by mixing the human hair and natural rubber in a two roll mill along with additives followed by vulcanization. This paper covers chemistry of hair, rubber and hair composite manufacturing and mechanical properties. Physical properties of natural rubber and hair composite are increase with increase in human hair.

Keywords: - *Human hair, Natural rubber, Composite, Vulcanization, solubility*

1. INRODUCTION

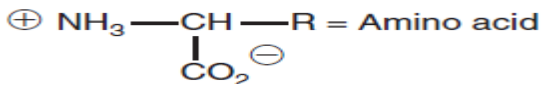
The interest in utilizing natural fibers as reinforcement in polymers has improved radically during the last few years. Lots of natural fiber use for reinforcement in rubber industries Like banana fiber, cotton fiber etc. They are cheap and give good properties. Human hair use as reinforcing agent because it is easily available, cheap, slow decomposition and give good strength. Slow decomposition of hair improve service life of composite. The study relates also to the effects of protein structure on the chemical and physical structures of protein-elastomer composites. The aim of the present study was to explain the influence of protein on the structure of spatial network of macromolecules as a number of node moles per the elastomer volume.

2. CHEMICAL COMPOSITION OF HUMAN HAIR

Human hair is a complex tissue consisting of several morphological components, and each component consists of several different chemical species. It is an integrated system both in terms of its structure and in terms of its chemical and physical behavior wherein its components can act separately or as a unit.

Depending on its moisture content (up to 32% by weight), human hair consists of approximately 65 to 95% proteins. Proteins are condensation polymers of amino acids, and the structures of those amino acids found in human hair. Because of the large number of chemical reactions that human hair is subjected to by chemical bleaches, alkaline straighteners, and sunlight exposure, many of these amino acids are converted to the amino acid derivatives. The remaining constituents are water, lipids (structural and free), pigment, and trace elements (generally not free, but combined chemically with side chains of protein groups or with fatty-acid groups of sorbed or bound lipid).

- General structure of amino acid human hair



3. SOLUBILITY OF HUMAN HAIR

Whether a structurally complicated material (solute) consisting of several components is soluble, partially soluble, or insoluble depends on several properties of both solute and solvent, or solvent blends. The state of solute, whether it is solid, liquid, or gas, has major effect on the solubility, in addition to physical properties of solute and solvent.

The concept of solubility in this series has been described by two different approaches. According to the first scheme, the dissolved solute does not change its chemical structure in the solution, i.e., it is recoverable by unit operation, such as distillation, crystallization, etc. In the second scheme, the solute undergoes dissociation, decomposition, or reaction, and its chemical structure changes. When polymers or biological macromolecules are dissolved in a solvent, the solutes lose their original structure and cannot be recovered in their original form. The first procedure is reversible, while the second is irreversible. The significant difference between the reversible and irreversible solubility is the chemistry of the solute in solution. If there is no interaction between solute and solvent, then there is no change in the composition of the solute and the separation can be performed after the solubility .

Whether a biological material is soluble or insoluble in water is determined not only by its structure and the forces holding the constituted molecules together, but also by melting point and enthalpy of fusion of the solute. In adding, the binding forces between the solute molecules and those between the solvent molecules play a important role.

High solubility in salt solutions is important for the practical use of most proteins. Protein solubility, in general, increases with increased pH in the range of pH 6.0 to 7.0. The affinity of a solvent for hair is determined by the following molecular properties: size, the presence of polarizable groups, electric charges, and the ratio of hydrophobic to hydrophilic groups. Small molecules and molecules with hydrophobic groups appear to have higher affinity for hair. There are some suggestions for selective solubility by particular hair types, but differences in structure, morphology, and protein structure between hair types may be the basis for the observed differences.

Several acidic or alkaline reagents have been proposed for dissolving hair samples, such as hydrochloric acid, sulfuric acid, nitric acid, perchloric acid, and NaOH solution. Human hair samples can be dissolved in hot 10 M NaOH solution within 15 min. In the procedure, about 0.1 g of the hair sample was digested in a 15-ml test tube with 0.2 ml 10 M NaOH over a hot bath at 90°C for 15 min. The digested sample solution was then analyzed for estimating body burden of organomercury components, thereby also providing an indirect measure of dietary intake.

Some test on solubility of hair is carried out by us some picture of those are shown below. Hair is dissolve in NaOH. As concentration of NaOH increase solubility increase. Hair is insoluble in acetone toluene.

Fig. 1: hair with concentrated NaOH

Fig. 2: hair with Ammonia buffer solution

Fig. 3: hair with Acetone

Fig. 4: hair with toluene

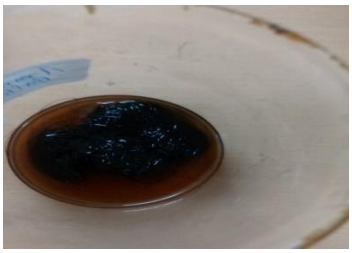


Fig.5: hair with dil. NaOH

4. MANUFACTURING PROCESS:

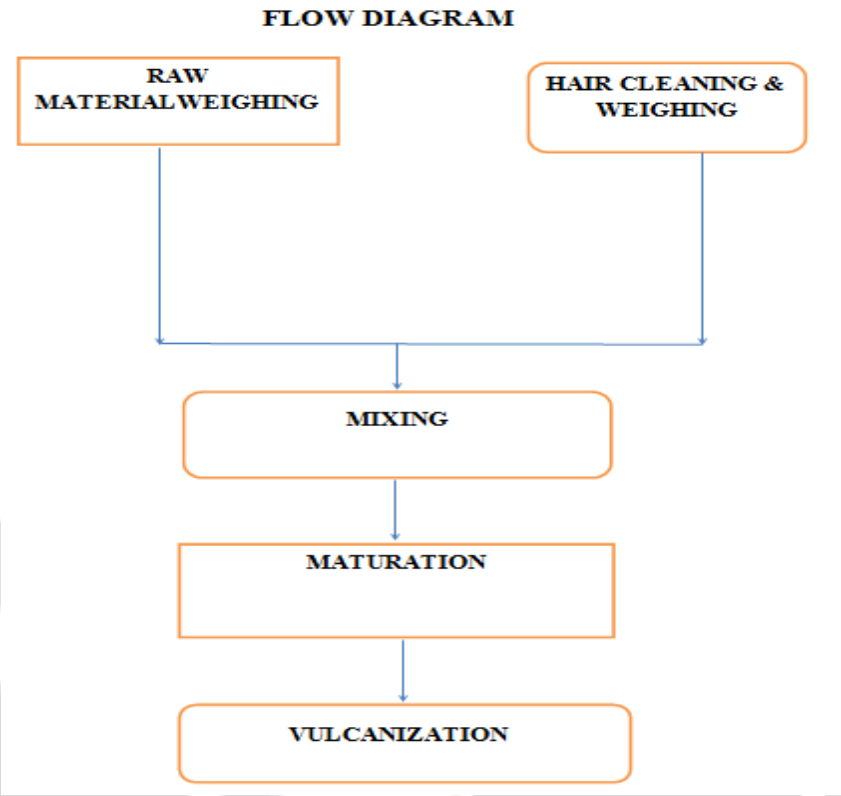


Fig 6:. Process Flow Diagram

Hair is waste material and it causes much problematic for drainage system. Normally waste human hair contains dirt, oil, and some other contamination. For using human hair as sort fiber all dirt and other contamination are must be removed. Clean hair and rubber additive weighing as per required PHR.

COMPOUND NO	M1	M2	M3
INGREDIENTS			
RSS	100	100	100
ZNO	5	5	5
STEARIC acid	1	1	1
MBTS	1	1	1
SULFUR	2	2	2
HS/TDQ	0.8	0.8	0.8
HUMAN HAIR	0	5	10

Table 1: composition of rubber hair composite

Rubber compounds were mixed on a 2 roll mixing mill at the rolls temperature 30 °C and friction 1.15. Natural rubber sheet was successively passed through the two roll mill. Since the two rollers in a two roll mill rotates in two directions with different speeds thus producing a frictional resistance which will rise the temperature, the natural rubber is turned into a waxy state. At this state the additives are incorporated followed by the addition of human hair in sequence and mixed for roughly 3 min. Then the sulphur is incorporated. The total process took around 20 min. The vulcanization of mixed compounds was carried out in a vulcanization mold at a temperature of 140°C at time τ90 determined from rheometric measurements.

5. TESTING AND RESULTS

5.1 Vulcanization Characteristics

Oscillating Disk rheometer used to determine the vulcanization characteristics of natural rubber and human hair compounds and also used for good quality control in rubber manufacturing processes, for research and development testing of raw-rubber compounded in an evaluation formulation, and for evaluating various raw materials used in preparing natural rubber and human hair compound.

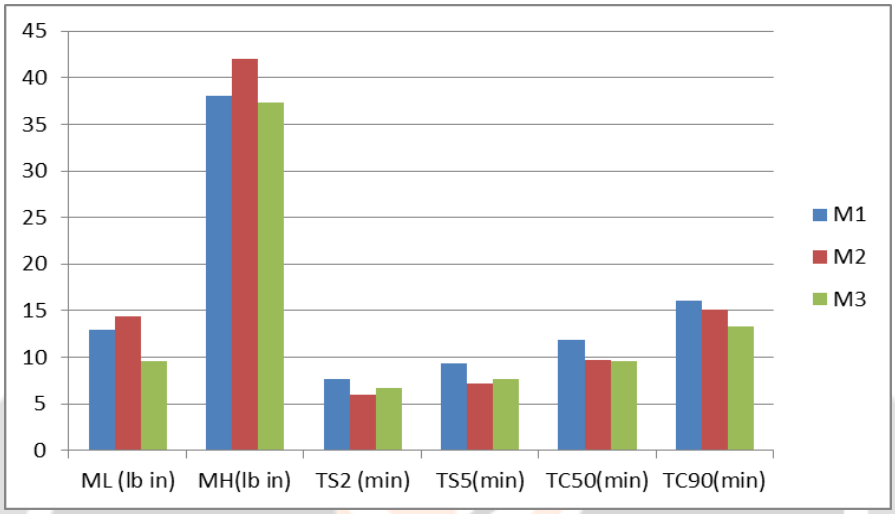


FIG. 7: Rheometer Data

5.2 Tensile Testing :-

The natural rubber and human hair composite compound tensile testing by the ASTM 412 method. The tensile strength is measure by the universal tensile testing machine. All materials and products covered by these test methods must withstand tensile forces for adequate performance in certain applications. These test methods allow for the measurement of such tensile properties. However, tensile properties alone may not directly relate to the total end use performance of the product because of the wide range of potential performance requirements in actual use. Calculate the tensile testing by using given formula:

$$\mathbf{TS} = \frac{F(BE)}{A}$$

Where:

TS = tensile strength, the stress at rupture, MPa (lbf/in.^{2}),

F$_{(BE)}$ = the force magnitude at rupture, MN (lbf), and

A = cross-sectional area of unstrained specimen, m^2(in.^{2}).

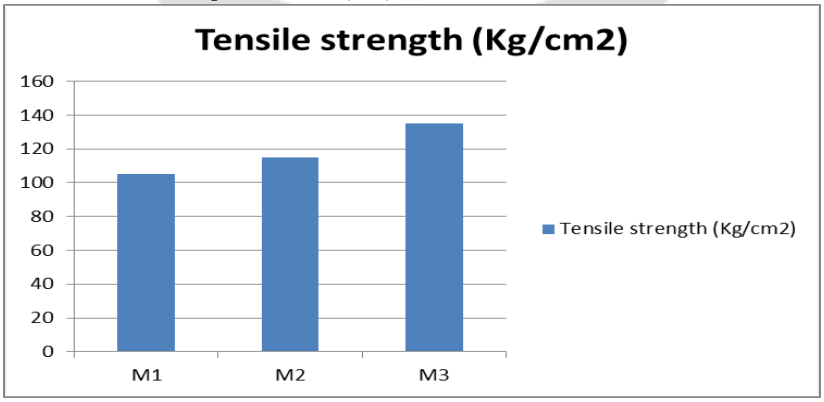
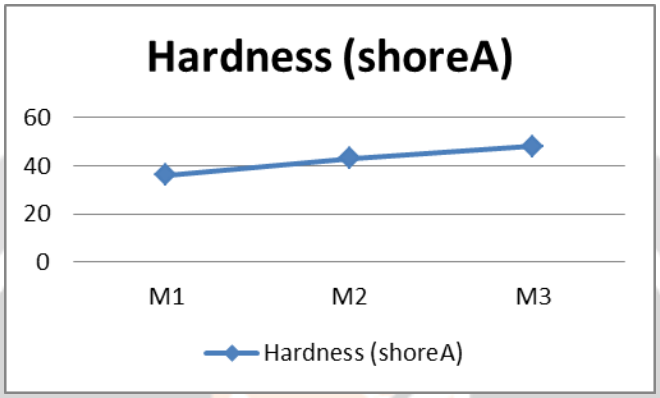


FIG. 7: Tensile Strength

5.3 Hardness testing :-

The Hardness test method is based on the penetration of a specific type of indentor when forced into the material under specified conditions. The indentation hardness is inversely related to the penetration and is dependent on the elastic modulus and viscoelastic behavior of the material.

This test method permits hardness measurements by the ASTM 2240 test method. The hardness durometer based on either initial indentation or indentation after a specified period of time, or both. Durometers with maximum reading indicators used to determine maximum hardness values of a material may yield lower hardness when the maximum indicator is used.



6. CONCLUSION

Physical properties of rubber are increase with increase human hair in composite. The tensile strength is increase with increase human hair in composite. By adding 5 PHR human hair 10 % tensile strength is increase, by adding 10 PHR human hair 20% tensile strength is increase. Cure time is decreasing as increase human hair in composite. Hardness is increase with increase human hair in composite. Hardness is increase 19% by adding 5 PHR human hair. Hardness is increase 34% by adding 10 PHR human hair.

7. REFERENCES

[1] Ankush Gupta Human Hair "Waste" and Its Utilization: Gaps and Possibilities. Journal of Waste Management Volume 2014 (2014), Article ID 498018, 17 pages.

[2] Richu J. Babu, Sony Mathew, Sharon Rony Jacob, Soney C. George, Jibin C. Jacob Optimization of Human Hair Length in a Natural Rubber Based Composite, Trans Indian Inst Met (2015) 68(Suppl 1):S87–S90 DOI 10.1007/s12666-015-0614-9.

[3] Ari L. Horvath Solubility of Structurally Complicated Materials: 3. Hair The Scientific World JOURNAL (2009) 9, 255–271 ISSN 1537-744X; DOI 10.1100/tsw.2009.27.

[4] Von Clarence R. Robbins Chemical Composition of Different Hair Types Chemical and Physical Behavior of Human Hair Springer 2012 Verlag C.H. Beck im Internet: www.beck.de ISBN 978 3 642 25610 3

[5] Jillian R. Richter, Roche C. de Guzman, Olga K. Greengauz-Roberts, Mark Van Dyke, Structure–property relationships of meta-kerateine biomaterials derived from human hair Acta Biomaterialia 8 (2012) 274–281.

[6] ASTM Standards 412 – 98a Standard Test Methods For Vulcanized Rubber And Thermoplastic Elastomers—Tension.

[7] ASTM Standards D 2240 – 00 Standard Test Method For Rubber Property—Durometer Hardness.

[8] ASTM Standards D 2084 – 95 Standard Test Method For Rubber Property—Vulcanization Using Oscillating Disk Cure Meter.