STUDY OF HEAT SENSITIVE GELATION OF NATURAL RUBBER LATEX USING POL YVINYLMETHYL ETHER (PVME)

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INTRODUCTION :

1.1. NATURAL RUBBER LATEX

Natural rubber can be obtained from the latex of Hevea brasiliensis. Which is a white liquid, similar to milk or cream. It is basically a colloidal dispersion of rubber hydrocarbon in an aqueous medium Apart from rubber hydrocarbon, latex contains protein, sugars, phospholipids and small amount of mineral substances.

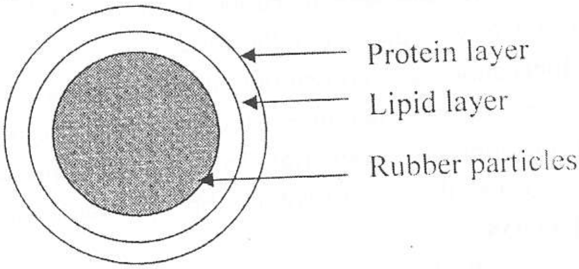


Fig. 1.1 The outlook of the rubber particle

Phosphoprotein layer will provide negative charge on the rubber particle surface and it will cause the stabilization.

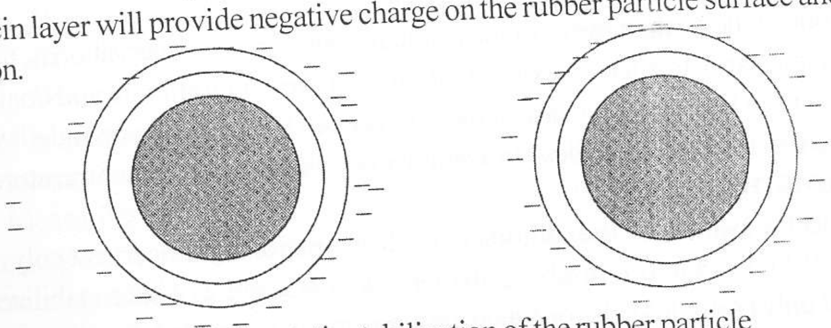


Fig 1.2 Electrostatic stabilization of the rubber particle

"The negatively charged particles of rubber dispersed in the medium prevent the particles from coalescing."[1]

The composition of the natural rubber latex vary with the factors such as seasons, soil condition etc.

Composition	%by weight of NR latex
Dry rubber content	30.0 - 35.0
Proteins	1.0 - 1.5
Lipids	1.0 - 2.5
Sugars	1.0
Inorganic materials	1.0
Water	60.0 - 65.0

Table 1. Typical composition of NR latex.

The density of untreated latex is 960-980 kgm^{-3}. The density of the latex decreases with increasing rubber content.

The pH of fresh latex is about 7.0-7.2 and isoelectric point is about 4.5-4.8. On standing in air, its pH value decreases to 5.8.

Natural rubber latex is destabilized within few hours after tapping mainly due to the fact that the bacterial action. Bacteria act on Sugars, like Quebrachitol, in the presence of oxygen to give formic

acid and acetic acid. These acids lower the pH value of the latex and spontaneous coagulation is result.

In order to prevent spontaneous coagulation of latex by bacterial action short term and long term preservative have been tried out.

In Sri Lanka, most latex based industries use preserved concentrated latex, and the non-natura rubber producing countries prefer to buy preserved concentrated latex to reduce the freight cost.

The main method of producing concentrated latex is centrifugation, where most of the non-rubber constituents are removed from the latex while increasing its dry rubber content to a value close to 60% by weight. In centrifuging, a high centrifugal force is applied to the latex by rotating in conical vessels, which low-density rubber particles are forced to the center, and the high-density serum is thrown toward the wall of the vessels.

Any rubber product cannot be used without improving its physical properties. To do this, we use vulcanization process. Rubber becomes a technically important ,material only after the discovery of vulcanization. Generally it penetrated all fields of human activity and offered new possibilities 0 application, today; the assortment of rubber products exceeds 30,000 items.

1.2. HEAT SENSITIVE GELATION

"In the gelation process, the latex gradually changes from a fluid system to a uniform, semi-rigid gel of the same shaped and size as the original.

Gel is one of the distinct forms of the resultant coacervate. Coacervation is, to any process, which destablishes latex to such an extent that the particles agglomerate and coalesce in large numbers.2 "The term heat sensitive describes latex, which has been compounded with an agent, which cause them to undergo rapid destabilization and gelation when the temperature increased.3

1.3. POLYVINYLMETHYLETHER :

"Latex can be heat sensitized by the addition of the heat sensitizing coacervant polyvinyl methy1 ether (PVME). Which is a non-ionisable polymer.,,[2] In that it acts as a latex stabilizer at ambient temperature and only promotes gelation when the temperature is elevated. Small amount of PVME is sufficient to cause large changes in the heat sensitivity.

Structure of PVME is

$$H\text{-}(CH_2\text{-}\underset{\substack{|\\ O\text{-}CH_3}}{CH})_n\text{-}H$$

The mechanism of heat-sensitization by PVME is believed to involve their adsorption at latex particle interfaces at room temperature and a subsequent loss of stabilizing power at higher temperatures. Loss of stabilizing ability occurs due to the dehydration of the material at its 'cloud point'. Cloud point is, the temperature at which the material precipitates out from aqueous solution

EXPERIMENTAL PROCEDURE

The objective of this study is, to find out how the heat sensitive gelation process changes with temperature.

2.1. PREPARATION OF LATEX COMPOUND

Before preparation of latex compound the total solid content of the latex was determined. Then latex was stabilized with 20%Vettum. Which is a nonionic surfactant. After that latex was de-ammoniated by blowing air across the surface of the latex whilst stirring the latex slowly. The de-ammoniation was continued until the pH reached to 9.5. Distilled water was added during the de-ammoniation process to maintain the total solid content at approximately the same level as its initial value. Then 20% neutralized formaldehyde was added to the latex until the pH reached to 7.6. "At the normal pH of ammoniated latex, the heat sensitizing power of PVME is low even in the presence of Zinc oxide,,[4]. Because of that, ammonia was removed, to reduce the pH.

After that additives were added within one-hour interval. "Sulphur was added as a vulcanizing agent. Which can be able to form cross-links between the rubber polymer chains. Elemental Sulphur has remained the most widely used vulcanizing agent for unsaturated rubbers. Zinc oxide (ZnO) was added as activator, which is able to increase the cross-linking. Zinc mercaptobenzthiazolate (ZMBT) was added as accelerator. By using accelerator vulcanization rate and cross-linking efficiency can be increased and the amount of sulphur can be reduced. "[1]

Formulation used to this study is

Ingredient	Wet (Parts by weight)
60% Natural rubber lated	167
20% Vettum solution	3.5
50% ZoO dispersion	1.0
50% ZMBT dispersion	1.25
50% Sulphur dispersion	1.5
15% PVME soluton	3.33
Water	33

2.2. Study of heat-sensitivity of the latex compound

Heat sensitivity was assessed by a dipping procedure using a former heated to the required temperature. Measuring the weight of the deposited film assessed the rate of the deposition. This procedure consisted of immersing a heated former into a beaker containing the latex compound. The used formers were hollow cylindrical glass tubes closed at one end.

Before use the formers, they were maintained at the particular temperature in an oven for 30 minutes.

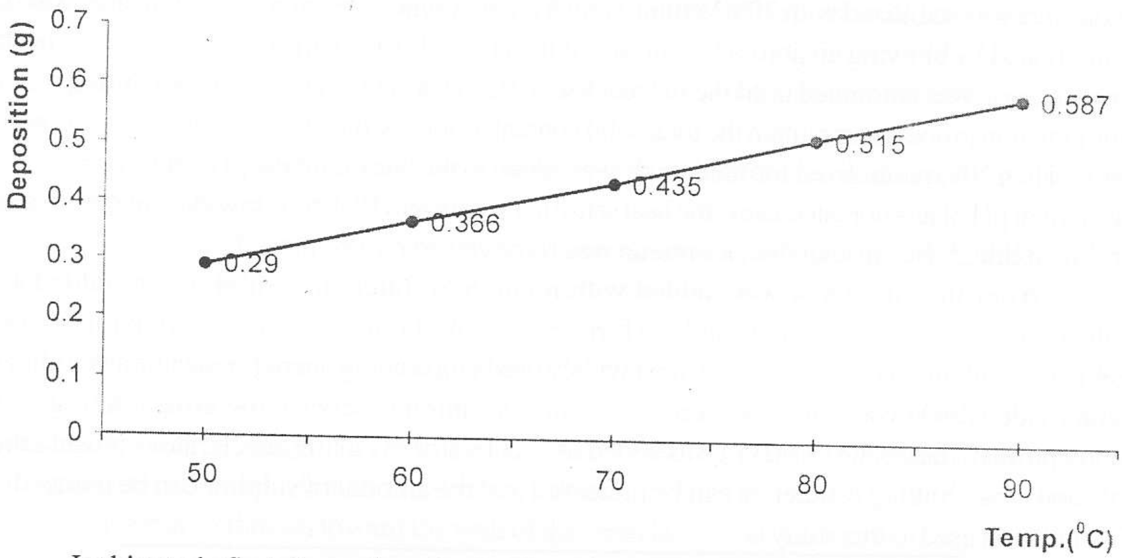
The former was dipped into the latex compound 7cm) and allowed to dwell for 60seconds.Then it was withdrawn from the latex. The formers with the latex deposit were then dried in an oven at 70°C for 60 minutes. Then they were left overnight at room temperature. The dried film was stripped from the former and the weight of the film was measured. The mean of the four weights was taken as the average weight of the film. This procedure was repeated for a range of temperature (50°C, 60°C, 70°C, 80°C and 90°C).

Storage stability of the latex mixes was assessed by viscosity measurements carried out at intervals up to eight days. To measure the viscosity Brook field viscometer was used at 60rev/min. Spindle No. of the viscometer is 62.

RESULTS AND DISCUSSION

Total solid content of the ammoniated latex is 62.2302.Which is the content of rubber and all non rubber constituents of latex. It is expressed as a weight percentage of the weight of latex. pH of the ammoniated latex is 10.73

Fig.1: Deposition Vs Temperature



In this study fig.! shows that, the amount of the deposition increased with temperature at pH 7.5. The amount of deposition has a linear relationship with the former temperature. Since the formation of latex gels by heat-sensitization depends upon the material of the former, the former temperature and the latex dwell time. Here material of the former and the dwell time were constant. So the formation of latex gels by heat sensitization depends only the temperature of the former.

The amount of the deposition increases with rate of the gelation process. The rate of the gelation process increases when temperature of the former is raised. It may cause by mechanical entrapment of the latex in the network or precipitate of PVME, which gradually form throughout the system.Otherwise it may cause by the adsorption on to the precipitate of the stabilizer.

Fig.2: Viscosity Vs Day

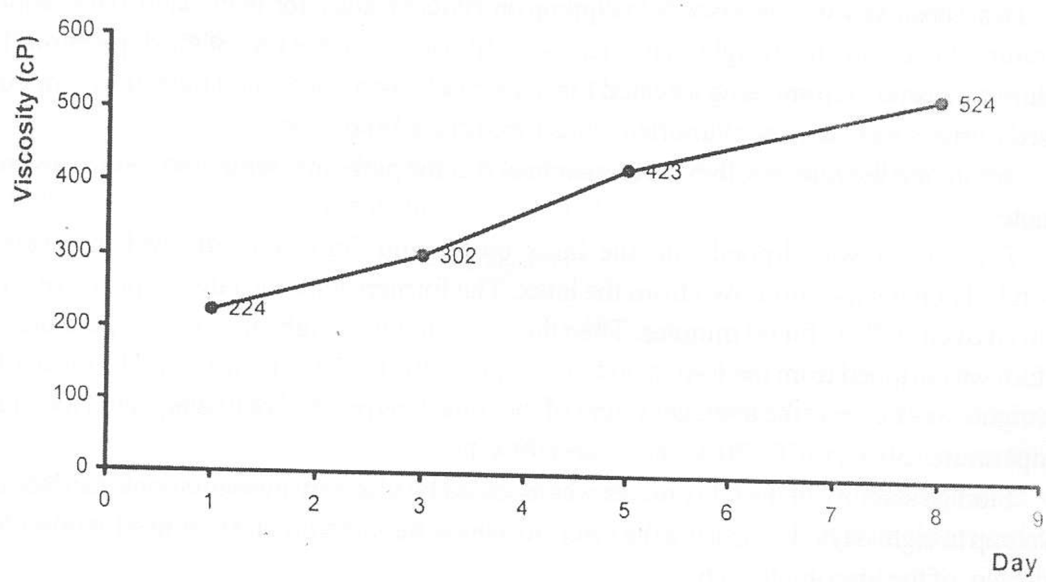


Fig.2. shows the variation of viscosity with time at room temperature (27°C-30°C). Viscosity increases with time. This viscosity increase reflects an increasing association of the latex particles The gradient of the increase is very small. Because within three days, there is no considerable change in viscosity.

CONCLUSION

The results of the study strongly indicate that, when the temperature increases 50°C to 90°C, amount of deposition shows 100% of increase. So, thickness of the article also can be increased by the increase of temperature.
The viscosity study indicates that the above-formulated latex has better storage stability.

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