VOLATILE FATTY ACID FORMATION IN NATURAL LATEX

Project work submitted to the Mahatma Gandhi University
In partial fulfillment of the requirements for the
Degree of Master of Science

BY
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APRIL 2005

CERTIFICATE

This is to certify that this project work ***"VOLATILE FATTY ACID FORMATION IN NATURAL LATEX"*** *is carried out by* ***Miss. ALICE ALEXANDER*** *under my supervision and guidance and that no part there of has been presented for any other degree or diploma.*

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रबड बोर्ड

THE RUBBER BOARD

(वाणिज्य एवं उद्योग मंत्रालय, भारत सरकार)
(Ministry of Commerce and Industry - Government of India)

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P&PD/P&QC/2005

June 14, 2005

CERTIFICATE

It is certified that project **"VFA formation in natural latex"** submitted by ***Miss Alice Alexander, M.Sc Polymer Chemistry, Catholicate College, Pathanamthitta,*** for the partial fulfillment of ***M.Sc. in Polymer Chemistry of M.G. University,*** is a bonafide record of research work conducted by her at Processing and Quality Control Division of Rubber Board under my guidance. The results obtained have not been used for obtaining any other degree.

Jt. Director (P&QC)

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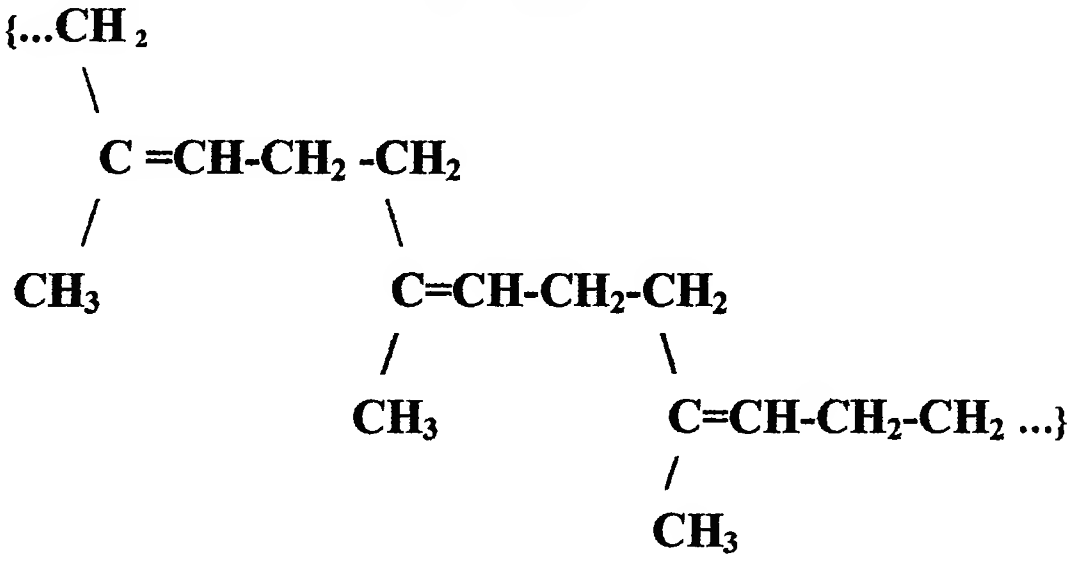
III

INTRODUCTION

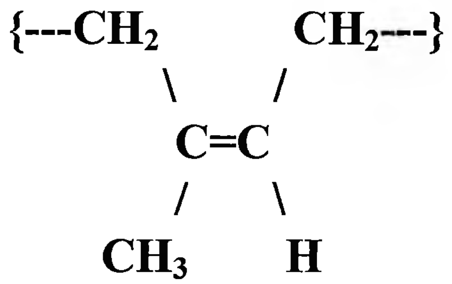
I. NATURAL RUBBER

Natural Rubber is obtained from certain types of plant species like Hevea- Brasiliensis of the family Euphobiaceae and Gayule ; however almost, the whole of rubber is obtained from the former species. Rubber is a polymeric material of high molecular weight which is capable of deformation under stress and resume its original shape when the force is removed. The crop from plantation is a milky white colloid known as latex. Latex is an essentially two-phase system, consisting of a dispersed phase and a dispersion medium. The dispersed phase or discrete phase consists of small particles, normally less than 5µ in diameter, the molecules of which are polymeric in nature. The polymeric substance is large in size and comprises of a basic chemical unit, cis 1, 4 - poly isoprene and is biosynthesized by a complex process involving proteins.

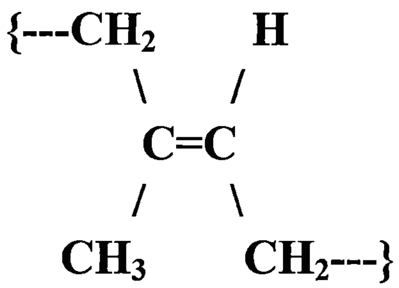
The polymer contained in latex is cis - 1, 4 - polyisoprene which has a density of 0.93 gmcm^{-3} at 20 ^{0} C . The structural formula of polyisoprene (C_5 H_8) n is shown below.



Because of the presence of olefinic carbon atom, cis and trans forms are possible. The trans form of polyisoprene is called “Guttapercha”. Both cis and trans forms are shown below:



cis – 1, 4 polyisoprene
(Natural rubber)



trans – 1, 4 polyisoprene
(Guttapercha)

In Natural Rubber, there is a bending back of successive isoprene units giving the molecule a coiled structure while Guttapercha shows straightening structure. It has a refractive index of 1.52 and dielectric constant of about 2.5. The latex is a constituent material in liquid milk form and consists of colloidal dispersion or it can also be called as emulsion of elastomeric material of rubber particles or globules in water ranging in various percentages. The sizes of particles vary from a wide range, 2milli microns to about 2 microns. These particles of latex either pear or spherical shaped and are composed of rubber hydrocarbons and are coated with absorbed layer of non-hydrocarbon substance like proteins and phospholipids. The estimated non-hydrocarbon contents in natural latex are about 2.5 to 3.5%. These non rubber materials may be either adsorbed on particle surface, or dissolved in the aqueous phase.

Rubber has specific and distinguished properties. It exhibits a special type of resilience or elasticity. By the end of 1st century itself effect of temperature on natural rubber was discovered. Its susceptibility to change the shape and becoming sticky in hot climate and hard in cold climate came to the knowledge. In 1923, it was discovered that naphtha was a useful solvent for rubber. A sandwich was made with two fold cloth of cotton called ‘double texture fabric.’ The method is still in use but is utilized with modified techniques for manufacture of water proofing cloths. As a consequence, rubber industry developed the process of manufacture of sheet and rubber coated textile.

Currently the source of rubber is either from nature (natural rubber) or man made (synthetic rubber). Natural rubber is a polymer with high molecular weight, the structure of which is cis-1, 4 –polyisoprene. The average weight of natural rubber varies from 30,000 to 10 million.

Blackley has defined latex as a stable colloidal dispersion of polymeric substances in an essentially aqueous medium. Lattices of different nature are obtained from several plants, in addition to those produced synthetically. Among the natural lattices, that obtained from Heveabrasiliensis alone is of commercial importance, even though the rubber obtained from guayale plants also has gained some importance. In rubber plants, the rubber hydrocarbon, cis polyisoprene is synthesized by a complex process involving some proteins. The pre rubber produced in the tree as latex is obtained by the process of tapping. The latex obtained can be processed to recover the solid rubber, or it can be processed to utilize the rubber in latex form.

The mechanical properties of natural rubber can be considerably improved by cross linking the long flexible molecular structure. In addition to natural rubber, several synthetic rubbers are also available now. A range of plants are known to produce rubber. About 895 species belonging to 311 general of 79 families yield rubber. The principal source of natural rubber is Heveabrasiliensis, a tree native to the Amazon rain forests. The commercial plantations of this tree have been in existence for the last 150 years. The plantation industry in India is about a century old. Latex is obtained from the tree Heveabrasiliensis and has a wide range of uses and applications in the industrial, domestic and commercial requirements.

The source material of natural rubber latex concentrate is freshly tapped field latex. After opening the tapping cut the latex flows out of a system of intercommunicating latex vessels in the soft bark. These vessels are arranged in rings with connections between vessels within a ring but seldom between rings. Latex is in fact of cytoplasm structure and contains i.e. ribosomes but seldom nuclei. Apart from rubber particles very freshly tapped latex also contains so – called lutoid particles which can be separated by centrifuging at low speed and more or less yellow/orange coloured. The composition of the fresh latex is rather complex due to its origin and the relative proportions of certain constituents (eg. Proteins and minerals) can show important variations depending on many factors (clone, season, tapping system). The same is true for its rubber content which is normally between 34 and 38%. As soon as possible the latex is temporarily preserved with ammonia (the quantity depending on the delay between processing into concentrate and harvesting the crop) in order to prevent bacterial contamination or at least to limit its effects.

Latex as a raw material for manufacture has several disadvantages. It is relatively unstable, requiring preservatives. The commercial product of concentrated latex is now a days prepared by centrifugation; and there are only two types made on a large scale:
HA (high-ammonia) latex, preserved with 0.7% ammonia
LA – TZ (low ammonia) latex preserved with 0.2% ammonia + 0.025% TMTD/ZnO + 0.04 – 0.05% lauric acid as ammonium laurate. In addition are available: PV latex. The Pre-Vulcanized latex is in wide spread use. Natural latex can be readily vulcanized in the liquid state and the product retains most of the good – processing characteristics of raw-latex concentrate.
Creamed and evaporated Latex: These lattices of 65 and 66% DRC respectively are produced each by only one producer in Malaysia.
Zero Protein Cream and Latex: Contains virtually no extracted proteins.

The mechanical stability (MST) is the only property of the standard specifications referring to a fundamental characteristic of colloidal systems – its stability.
The rubber particles in the latex are covered with a protective bilayer of phospholipids and proteins. In the ammoniac medium the lipids hydrolyse under formation of higher fatty acids soaps (HFA).
HFA formation during the first 6 – 8 weeks after ammoniation parallels development of MST, increasing from 100 seconds up to 800 seconds and over. This process has been studied in some detail for HA lattices; in LA lattices like LA-TZ the MST has to be boosted by addition of soap, normally ammonia – laurate, at about 0.05% on the latex.

The importance of Vulcanization.

The fundamental change caused by vulcanization is of the greatest possible importance. It is a change in condition effected by heating with sulphur, and is best defined by contrasting the difference in physical properties. Rubber articles prepared posses a foul odour and were sensitive to heat and cold. Rubber articles get soften when heated and brittle on cooling. Goodyear from 1831, aimed at improving the properties of rubber. The discovery of "vulcanization" was the foundation up on which the rubber industry is built. Goodyear patented his discovery in 1841. The preparation of vulcanized latex or "vultex" may take place at room temperature or at a temperature lower than that of the boiling point of water. It is necessary to adjust the proportions of sulphur, accelerators and activators. The ammonia present in preserved latex is sufficient to stabilize the mixing.

1. COMPOSITION OF NATURAL LATEX

In addition to rubber hydrocarbon & water, natural latex contains several non rubber substances, both organic and inorganic in origin. Typical composition of natural latex is given below:

TYPICAL COMPOSITION OF FRESH NATURAL LATEX

Constituent	Proportion % m/m of whole latex
Total solids	**36**
Dry rubber	**33**
Proteins	**1-1.5**
Resin matter	**1-2.5**
Ash	**upto 1**
Sugars	**1**
Water	**ad 100**

The presence of some of the non rubber substances, is essential either for synthesizing the rubber hydrocarbon or imparting colloidal stability to latex. Other constituents also have some physiological functions in the biosynthesis of rubber hydrocarbon.

Softened rubber is produced by adding to the latex an emulsion of an organic peroxide of the general formula R_1-CO-O-O-CO-R_2 ,where R_1 and R_2 are aliphatic or aromatic radicals, and then coagulating the latex and simultaneously breaking down the emulsion so that the peroxide is deposited in the coagulam. Benzoyl peroxide is a suitable substance to add to the latex data showing the effect of the addition of various proportions of the peroxide on the plasticity of the rubber being given. The softness of the rubber is markedly dependent on the conditions of drying in the initial stages. When drying normal sheet rubber, smoke-drying produces a softer sheet than air drying, but the reverse is the case when benzoyl peroxide is present. It is therefore recommended that if it is desired to prepare smoked sheet and also to secure the utmost softening from a given amount of benzoyl peroxide, the sheets should be submitted an initial drying period in hot air at 120°F, free from smoke, followed by the required amount of smoking. The invention relates to the treatment of latex and the preparation of a purified rubber having a reduced content of nitrogen and an improved resistance of absorption of water as compared with the normal plantation product.

The invention comprehends both the method of treatment and the product obtained.

To prevent yellow colouration in the preparation of crepe rubber, the treatment includes the addition to the latex of aryl or alkyl mercaptans, or substance releasing their active radicals, in proportions not exceeding 0.1% by weight calculated on the rubber, this being insufficient to effect appreciable softening of the rubber, but effective to beach the resulting product. Ageing characteristics of natural or synthetic polyisoprene elastomers are improved by adding to the latex of the raw polymer reducing agent, including polyalkyline polyamines, eg. diethylene triamine , tetra-ethylene pentamine; alkali metal sulphites or bisulphites; aromatic amines such as benzidine or phenylene diamine. The formation of volatile fatty acids is inhibited by adding, before or immediately after concentration, an enzyme poison, especially not more than 0.2% of zinc oxide, in addition to any bactericide. Coagulation of the latex thus avoided. Bacteria are prevented from entering latex while it is still in the tree and during emergence, with the resulting production of very white concentrate ~~latex of very low volatile fatty acid content,~~ of sheet rubber free from fermentation bubbles, and of very pale crepe rubber. Methods of protection against infection include application of alkaline detergent bactericidal and bacteriostatic dressings to the tree around the region of tapping, in conjunction with antibiotic injection.

1. i Spontaneous Coagulation of Latex

Fresh Hevea latex can be kept fluid only for a few hours. A few hours after tapping, latex thickens and on further keeping the whole mass is coagulated. This spontaneous coagulation is different from that of coagulation by acids, as the former occurs at p^{n} above 6, while the latter occurs at P^{n} below 4.8. Spontaneous coagulation is believed to be due to the formation of soaps in latex by the saponification of organic glycerides and lipoids. The soap anions strongly absorb on rubber particle surface. They then react with magnesium and calcium ions forming insoluble soaps. The rubber particles thus lose their charge and agglomerate leading to complete coagulation.

1. ii Assisted Biological Coagulation of Latex

Untapped rubber latex within the tree that is not damaged is practically sterile, free from bacteria, yeasts and fungi. After tapping, it becomes heavily contaminated by micro organisms. These micro organisms originate largely from crevices of the outer bark, from the residual scrap rubber during tapping and collection and also from aerial contamination. Natural coagulation, referred to as “auto coagulation”. In this coagulation process the use of acid is eliminated. It has some disadvantages: it is time consuming, coagulation is incomplete and the rubber produced has a relatively low P R I and an offensive odour. All the drawbacks of the auto coagulation can be over come by increasing the content of carbohydrates available for microbial breakdown. This Assisted Biological Coagulation (ABC process) is much more rapid than auto coagulation.

The possible substrates chosen for studies on the ABC process, because they are waste products of local industries and therefore readily available are molasses and waste pineapple juice, containing 50% and 8-10% sugar. The molasses was added to latex as a 10% solution in water while pineapple juice was used undiluted. The speeding up of biological coagulation by ~~the ABC~~ process improves the properties of the finished dry rubber as compared with that resulting from auto coagulation. It is of paler colour and has a pleasant odour. Pineapple juice is better than molasses in producing an even lighter colour. Technological properties of rubbers derived from the ABC process are found to be satisfactory, provided the coagulum is immediately processed. Because the latex is coagulated undiluted, naturally occurring substances that accelerate cure are largely conserved.

2. COLLECTION AND PRESERVATION OF LATEX

Latex is obtained from rubber tree (Hevea Brasliensis) by tapping the tree. In this way the latex ducts are cut and latex flows out of the cut. A white coloured syrupy liquid called latex is collected in a suitable container. A small amount of preservative is added to prevent coagulation. Thus latex is carried out to the central collecting station, where it is strained through a sieve to remove particles of bark and dirt. It is sent to factory for further processing.

Natural latex, if left unattended gradually thickens within a few hours after tapping and then undergoes coagulation. This is followed by putrefaction at a later stage with the development of mal odour. Putrifaction is brought about mainly by bacteria. For preventing spontaneous coagulation and putrifaction, latex has to be preserved by the addition of suitable chemicals.

2. i **CONDITIONING OF LATEX**

The proper conditioning of latex is to produce a basic product which may be employed in the greatest number of useful processes without the necessity of doing work other than that required for proper compounding. To arrive at such a goal it is necessary to consider latex from the standpoint of preservation, collection, coagulation, concentration, purification, and the effect of such factors on the physical characteristics of the product itself. Latex at the time of tapping may be defined as an aqueous buffered neutral system containing water-soluble crystalloids and fatty acid esters, in which small rubber particles are dispersed by means of a vegetable protein.

PRESERVATION

The term preservation we are including not only methods that prevent bacterial action or guard against outside infection, but also methods which involve the use of actual stabilizers for the improvement of mechanical stability. There are two phases of preservation – sterility and mechanical stability. In the first, we deal with disturbances that generally occur with in the material itself. In the second we deal with disturbances that occur either within or without. We need as preservative materials that will qualify or help against both contingencies. It is essential that a preserving substance should prevent bacterial action on or fermentation of protein and like materials. The proper conditioning of latex to be able to maintain the original state of dispersion when any serious stress is put up on it.

There have been many materials proposed and applied fro the preservation of latex. It would seem that not a great deal of difficulty should be encountered in finding suitable materials. It would seem that germicides useful in many of the other different arts would also find a use in the preservation of latex. In a simple latex system it may be noted that the rubber particles are kept dispersed by means of a protein and that the dispersion has a neutral reaction and contains salts.

One way to prevent the bacterial putrefaction of a protein is to change its P^H by making it either more acid or more alkaline. As our definition tells us that the protecting protein found in latex is on the basic side of its iso-electric point we would surmise that the easiest way to prevent bacterial activity by change of P^n would be to make the system more alkaline and that is why ammonia prevents putrefaction. In the proper amount it is basic enough to prevent bacterial growth.

Freshly tapped latex contains fatty acid esters. It has been shown that the fatty acid radicals of these esters are in the main those of oleic, linoleic, and stearic acids. When ammonia or any other base is added to latex, not only do we raise the P^n of the system but we also tend to hydrolyze these fatty acid esters and in the process form soaps. These soaps in their turn act as stabilizing bodies for the dispersed system. Ammonia is an ideal preservative, as when it is added to a normal latex in sufficient amount it not only prevents bacterial action but also forms stabilizing soaps from the fatty acid esters naturally occurring in the latex. The chemical, ammonia, well embodies the two actions mentioned above as needed for complete preservation, and in considering any other methods these two aims must always be clearly kept in mind: prevention of bacterial infection, and the maintenance of stable dispersions.

The alkalinity of the ammonia helps to increase the negative electric charge carried by the particles. This charge may be yet further increased on the alkaline side of the iso-electric point by the adsorption of multivalent negative ions which in this way give rise to even greater stability than would be produced by the use of ammonia alone. Due to the nature of tapping all latex may be considered infected for inoculated with bacteria. It is desirable that a preservative be added as soon as possible after the latex comes from the tree. In the proper conditioning of latex, if ammonia is used, it is desirable that the ammonia be added to the latex as soon as possible after tapping. It has never been proved that ammonia of itself is specific poison for bacteria in latex. Their death is due primarily to the high P^n to which ammonia brings the latex.

In the practical use of ammonia it is necessary first to apply the ammonia as soon as possible so as to prevent immediate putrefaction; to apply the ammonia in sufficient quantities to react with some of the fatty acid esters so as to form soap for stabilization; to apply it in quantities to maintain the P^n at a sufficient level to permanently prevent putrefaction; and to utilize sufficient ammonia to precipitate certain of the undesirable mineral constituents such as magnesium, calcium, and phosphate ions that are found in the dispersion. In the case of other modifications such as creamed or centrifuged products the proper amount of ammonia will be determined by the concentration and the degree of purification of the product.

Just as ammonia seems to be an ideal preservative from both angles, so other mono-valent alkalies, for example, caustic soda or caustic potash, may be considered suitable preserving agents. Such substances furnish high P^{n} and also saponify fatty acid esters to form soaps. Such materials are excellent but they have the disadvantages of being non-volatile and of being not easily separable from the dry residuum when the dispersion is broken. They have a further disadvantage in that too high a concentration of these materials, especially of caustic soda, causes creaming of the latex, that is, rising of the rubber particles in the water phase – a condition highly undesirable commercially. It is true that some successful commercial use has been made of this type of preservative in the transportation of latex.

Formaldehyde also, was tried as a preservative for latex. It was found to be from the viewpoint of putrefaction an excellent one. However the physical qualities of the resulting latex were quite different from those resulting from the use of ammonia. The latex became more viscous, and in the course of time, dependent up on the amount of formaldehyde, coagulated without necessarily going through a putrefactive stage. In other words this preservative fell down because it was unable of itself to maintain the rubber in a dispersed state. By the introduction of formaldehyde alone the neutral aqueous dispersion became acid, gradually thickened, and eventually coagulated. However, more recently it has been found that if formaldehyde is first added to latex and is then followed at some later period by the addition of a base, very excellent preservation is accomplished, that is the dispersion is stable against infection and also against mechanical handling and agitation.

There have been recent proposals for the use of amines, especially aliphatic once, as preserving materials. Such bodies are quite similar to ammonia and would possess the dual function of preservation. They also would possess in most cases high volatility and could be easily removed from the product. Their use may be retarded on account of cost, unpleasant odor, and their effect on the action of many of the high-powered vulcanization accelerators. The advantage of such agents seems to reside in the claimed better protection afforded against both putrefaction and mechanical as well as chemical stability.

The use of oxygen in one form or another has also been proposed as a means for stabilizing latex. The use of such material alone is so far not practical. It is necessary also to have some type of germicide present. The interesting feature is that small additions of oxygen, whether added as such or as air or by the use of oxygen – producing materials such as hydrogen peroxide, or other peroxides, increase the mechanical as well as the chemical stability of latex. At the same time it apparently alters the physical characteristics such as viscosity, surface tension, and colour. It also produces changes in the resulting rubber. It would seem then that this type of stabilization may result on further experimentation in a useful method for conditioning latex.

Whether or not the use of oxygen as a definite stabilizer materializes, the question of oxygen absorption in the conditioning of latex must be considered, as from the time it leaves the tree until it has actually been freed of its rubber latex is exposed to atmospheric air conditions in some way or another. To be brief, the absorption of oxygen by latex is dependent upon the temperature, state of preservation and the P^H of the system. A latex preserved in such a way as to prevent putrefaction absorbs oxygen depending up on the P^H to which the system is placed, the absorption increasing with an increase in P^H up to a certain point, which occurs at a P^H somewhat less than 10. Beyond this value the absorption rapidly falls off. This statement holds for lattices preserved on the basic side of neutrality.

Another method of preservation which has latent possibilities is the production of an acid latex. There are some methods described in the recent literature which indicate that it is quite likely such a process may be used commercially. This method of preservation consists in lowering the P^H, that is, increasing the acidity, sufficiently to prevent bacterial action, and using stabilizing agents if necessary in order to pass through the iso-electric point of the latex stabilizing protein. The immediate practical application of such a process is not expected, as difficulties of transportation, the necessity of careful addition of acid on the estates and the lack of formation of natural stabilizing bodies in such a method seem to forbid any immediate use of this unique method.

COLLECTION

It is a common belief that a rubber tree produces latex independent of all facts other than that it is a rubber tree. To a certain extent it is true. It is also true that each rubber tree may produce a different latex from any other rubber tree. In other words, rubber trees are influenced by their environment, which includes such items as geographical location, climate, soil, method of tapping and the seed from the rubber trees are produced. All of these factors produce variations in the composition and properties of the latex.

Roughly, the larger proportion of latex comes from a square whose side is approximately one thousand miles long. Included in this square are large bodies of water, mountain ranges, coastal plains, swamps, and jungles. In other words, it can be seen that in order to ship from the many million trees that produce our rubber it is necessary to consider difficulties to be overcome in collecting from outlying stations far away from the ports of embarkation. It is necessary therefore to properly time the tapping, loading, and preservation schedules in order to compensate for long and short hauls.

Directly coupled to the geographical difficulty mentioned above we have a second variation – that of soil. As the trees obtain their nourishment from the soil, they are going to be influenced by the food they eat. So, independent of other factors, differences in soil, even from contiguous estates, will produce variable effects on the resultant lattices. For example, it is known from experience that latex derived from the upper portions of the Malay Peninsula presents entirely different ash characteristics than the latex derived from the northern coast of Sumatra. It is necessary, then, for the proper conditioning of latex to understand these differences and to overcome them so far as possible by the practice of bulking latex and by the employment of suitable fertilizers. Such a problem is one of far reaching consequences and demands the attention of all rubber growers. Heretofore the study of manuring was mainly concerned with the yield of rubber. Today it is not only concerned with that factor but must be thoroughly concerned with the effect that such manuring will have on the non-rubber constituents of the latex produced. It is quite likely that appreciable differences in mineral constituents as well as other constituents can be greatly influenced by the type of fertilizer employed.

Another factor that must be considered is the change of season. While the average temperature does not change a great deal from day to day the amount of rain fall from month to month is quite variable. There has been some work indicating how the variations in the physical properties of a vulcanized sample follow the rate of rain fall from season to season. We know that rain fall influences to some extent the total solid content of latex, a property which for proper conditioning should be quite accurately controlled.

Another item which cannot be ignored is the method of tapping. The rate of flow of latex from a rubber tree and the ratio of its rubber to non-rubber constituents depend to a great extent on this factor. For example, there are in use two general systems of tapping – alternate monthly and alternate daily. In the first case, the concentration of latex obtained in the early part of the month is considerably higher than obtained in the last half of the month. On the other hand, with alternate daily tapping the concentration of latex remains practically uniform from day to day and only varies from season to season, that is, from the dry season to the rainy season. The ratio of non-rubber constituents to rubber appears to vary inversely as the concentration of total solids. It is easy then to see that due consideration must be made in regard to the method of tapping. In fact a number of companies tap their latex in such a manner as to produce lattices of different but uniform characteristics. By the proper bulking of these different types they are enabled to offer to the market fairly uniform lattices suitable for particular purposes.

COAGULATION

Coagulation is the antithesis of stabilization. In the latter case we attempt to add materials or keep materials in latex that will prevent the rubber particles from getting together. In coagulation we simply desire the reverse process, that is, a clotting of the particles so as to form a solid coherent mass.

If it is desired to obtain crude rubber such as crepes and sheets the process is quite simple. It consists in treating latex with small amounts of dilute acid, generally acetic or formic acid, in such a manner as to bring the system to a P^{n} corresponding to the iso-electric point of the protein, allowing coalescence of the rubber removal of the coagulum, and the washing and drying of the resultant sheet. The details of such processes are duly described elsewhere.

If it is desired to obtain sprayed rubber the latex is moderately stabilized and then sprayed in to a counter hot air current in such a manner as to completely evaporate the water. More recently sprayed rubbers of exceptional softness and improved resistance to fatigue flexing have been prepared by certain conditioning treatments of the latex prior to spraying. Such methods in the main are concerned with the introduction in to the latex of ammonium salts which break up at the spraying temperature and chemically act on the non-rubber constituents to produce the beneficial effects. It would seem that these developments should in the near future become commercially important.

If it is desired to form a pulverulent type of rubber, sufficient stabilizers are added to the latex to coat the rubber aggregates when dried and prevent them from coalescing when sprayed. This process is in its infancy and cannot at this time be properly appraised.

If it is desired to manufacture rubber articles directly from latex, ~~the primary concern of the latex producer is adequate preservation~~ of the latex, as in most cases the fabrication of articles from latex is carried out at distances far removed from the source of supply. Since each of the many methods for direct use of latex requires specialized conditioning treatments, these are rightly the problem of the latex user rather than of the latex producer. The few general principles applicable to all such treatments will be taken up under special applications. Suffice it to say that coagulation directly in the shape of articles can be effected by removal of water, by the addition of acid, or by a filtration process. By any one of these methods the rubber particles are destabilized and are caused to flocculate, producing a continuous film of rubber.

Improvements in the preservation of latex

Hevea latex concentrate containing less than 0.5% and more than 0.15% ammonia is preserved by the addition of selenium alkyl dithiocarbamate (eg. selenium diethyl dithiocarbamate). Between 0.01% and 0.1% of a surfactant (eg. ammonium laurate) also may be added. It has been found that a considerable number of bacteria survive the usual methods of preserving latex, for example by the addition of ammonia. The invention claims the use of small proportions of a sulphonamide. These compounds are stable in an alkaline medium and can be mixed to give solutions which are micro-organisms. The sulphonamide may be sprayed in to the tapping cut, or added to the collecting cup or to latex already containing ammonia. The concentrations should exceed 0.001%. A novel type of raw natural rubber is prepared which differs from ordinary natural rubber in that it has less tendency to swell at the calendar nip or extruder die even when it is uncompounded or only lightly compounded with fillers and plasticizers. It calendars, extrudes and otherwise moulds with a remarkably smooth surface after only a short period of mastication. It provides a method of preparing raw natural rubber in crepe or sheet form by coagulating natural rubber latex which has been mixed with latex that has been subjected to vulcanizing ingredients which have been removed by centrifuging. The preservation of latex concentrates can be done by the addition of antibiotics. Known latex preservatives permit the survival of bacteria. Antibiotics, eg. penicillin, streptomycin, oxytetracycline, chlortetracycline and chloramphenicol, are claimed as preservatives for natural rubber latex and these can be sprayed on the tapping panel, poured in to the tapping cup, or added to the latex at the collecting station. The latex is then concentrated and a detergent, which may or may not be bactericidal or stabilizing soap is added to increase its mechanical stability.

The invention relates to the preservation of natural rubber latex, both on short or long term basis. On a short term basis, anti-coagulants are added the latex prior to the making of sheet and crepe, and temporary preservatives are added to it prior to the preparation of concentrate. On a long- term basis, it is for the preservation of latex concentrates during shipment and storage prior to use. The temporary preservation of fresh latex is of importance in avoiding blemishes in sheet rubber produced from the latex, particularly bubbles and dark colourations. The additives of this specification, ammonia and boric acid are superior to formaldehyde and ammonia in that a sheet of light colour is produced.

The invention relates to the preservation of natural rubber latex obtained from Hevea brasiliensis, both on a short term basis for fresh latex, including anticoagulants added to the latex prior to the making of sheet and crepe, temporary preservatives added to latex prior to the preparation of concentrates and on a long term basis for the preservation of latex concentrates during storage and shipment prior to use. It is desirable in carrying out the preservation treatment to add ammonia and boric acid anticoagulant (also referred to as ammonium borate) as soon as possible after tapping although appreciable improvements of the product are effected if the anticoagulant is added at any time before acid coagulation.

Hevea latex, concentrated and preserved by the usual means is relatively unstable when first prepared but usually 'matures' during shipment, acquire a degree of stability acceptable to the user. Latex from some of the newer clones is extremely slow to mature and more over has a lower degree of stability after maturation. Mild oxidation accelerates maturation, the rubber is thereby rendered softer and more susceptible to ageing. A liquid bactericidal dressing of a given composition is painted round the tapping cut on the tree and is effective for several months in giving increase yields of improved quality latex, eg. very white concentrated latex of low initial volatile fatty acid content. This gives sheet rubber tree from fermentation bubbles or very pale crepe rubber. The method is slightly less effective than the antibiotic injection method.

Improved durability and crystallization resistance are obtained by treating rubber with a thiol compound. It is now found that natural latex contains inhibitor which is removed by adding formaldehyde and allowing to stand hours and preferably 48 hours before reacting with the thiol. Intermediate stages of dilution and stabilization may be included in the process. A masterbatch is made by admixing an aqueous solution of polyvinyl alcohol with rubber latex co-precipitating the two by coagulating the latex. Also claimed is method of producing a dry rubber bend having superior processing properties by blending the masterbatch in to a dry natural rubber or synthetic rubber in amount such as to provide a blend containing 10% to 20% of polyvinyl alcohol by weight of the final bend. A reduction in extrusion swell and an increase in extrusion rate is achieved by using the resulting blend.

2. ii Attributes of a preservative

The essential requirements of a chemical to function as preservative are given below:

1) The bacterial contamination in sterile field latex may lead to putrefaction. The primary requirement of any preservative is that it should preserve latex against spontaneous coagulation and putrefaction. Using sugars in latex as substrate, the micro organism liberate volatile fatty acids (VFA) in latex and destabilize it. Therefore the preservative must *destroy the micro organism that lead to putrefaction.*

2) The chemical that is used as a preservative should be able to *enhance the* P^{n} *of latex.* Since the P^{n} of field latex is about 7, the stability of latex is due to adsorbed proteins and phospholipids and higher fatty acids on the surface of rubber particles.

3) Metallic ions like magnesium can form insoluble products with proteins or higher fatty acid anions will neutralize the negative charges on rubber particles and will destabilize the latex. Thus preservative must be able *to deactivate the harmful metallic ions.*

4) It should not be harmful to people and should not have adverse reaction on rubber containers of latex and *should be cheap, readily available and convenient to handle.*

3. PRESERVATIVES

Ammonia is the only preservative, it is added to the extent of 0.7-1.0%. It is called high ammonia latex. Latex can be preserved with lower levels of ammonia, along with preservatives.

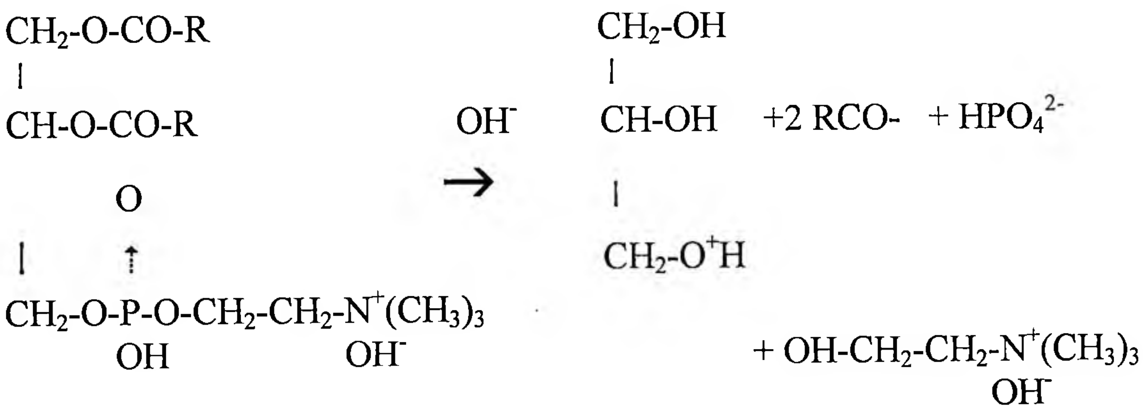
a) Boric acid as 0.04%. Lauric acid in the form of boric stearate is added to the latex.

b) To prevent from coagulation and bacteria, fresh latex is preserved with the following chemicals. 100 parts of fresh latex are presserved with 0.2% secondary preservative, sodium pentachlorophenate this is also available as penta chlorophenate with 0.2% ammonia.

c) Commonly used preservatives as primary and secondary are 0.2% ammonia and ZDC (Zinc diethyl di-thio carbonate) 0.1% by weight of latex duly dispersed and emulsified by 0.02% lauric acid is an effective preservative.Latex is transported to mill all over the country and abroad. Therefore preservatives are essential to be added for prolonged storage. Ammonia is added at the earliest possible time when received from rubber estate. Later on the secondary preservative specified may be added.

3. i Ammonia as preservative – HA latex

In presence of ammonia, the density of the bound electric charge on the rubber particles and the electrokinetic potential of the interface between rubber particles and the aqueous phase are increased, there by increasing the colloidal stability of the latex. In presence of ammonia, the phospholipids in latex undergo slow hydrolysis, liberating higher fatty acids (HFA); the HFA anions are strongly surface active and add to the colloidal stability of latex.



$$\begin{array}{l} CH_2\text{-}O\text{-}CO\text{-}R \\ | \\ CH\text{-}O\text{-}CO\text{-}R \\ \qquad O \\ | \qquad \uparrow \\ CH_2\text{-}O\text{-}P\text{-}O\text{-}CH_2\text{-}CH_2\text{-}N^+(CH_3)_3 \\ \qquad OH \qquad\qquad OH^- \end{array} \xrightarrow{OH^-} \begin{array}{l} CH_2\text{-}OH \\ | \\ CH\text{-}OH \\ | \\ CH_2\text{-}O^+H \end{array} +2\,RCO\text{-} + HPO_4^{2-} + \begin{array}{c} OH\text{-}CH_2\text{-}CH_2\text{-}N^+(CH_3)_3 \\ OH^- \end{array}$$

Ammonia is a very effective bactericide if the level exeeds 0.35m/m on the whole latex. Ammonia is able to deactivate some metallic ions, the most important among these being the precipitation of magnesium in presence of orthophosphate anions.

$$Mg^{2+} + NH_3 + HPO_4^{2-} \rightarrow Mg(NH_4)PO_4$$

Some other polyvalent metallic ions are precipitated as hydroxides. The auxiliary requirements stated earlier are also satisfied by ammonia. Hence ammonia was utilized as a common preservative for latex. When ammonia alone is utilized as a preservative its contents is about 0.7 – 0.8% and this latex is known as High Ammonia (HA) latex.

3.ii Technological Behaviour of HA Latex and films

HA latex can be compounded and dipped films prepared from it have high strength. HA latex can be prevulcanized using sulphur and accelerators using organic peroxides. HA latex shows excellent performance in foam manufacture and in the extrusion of elastic thread. Further HA latex is found to be more suitable for radiation vulcanization than low ammonia latex. A method of concentrating or creaming rubber latex comprises treating the latex with an organic colloid in the presence of a substance, which is neither alkaline nor acid and is more volatile than water. Latex is creamed by the addition of water solution derivatives of a fatty alcohols containing 6-8 carbon atoms per molecule, e.g. the sodium salts the sulphonated alcohols obtained by the hydrogenation of coconut oil or sulphonated lauryl alcohol.

3. iii Low Ammonia Systems

The above mentioned disadvantages of high ammonia lattices prompted people to think of lattices preserved with smaller quantities of ammonia. At low levels, bactericidal activity of ammonia is less. Hence ammonia is supplemented with some other bactericides. Such combinations are collectively known as low ammonia preservation systems.

3. iv Limitations of Ammonia as a preservative

A major disadvantage of ammonia as a preservative is that it interferes with certain established latex process. Thus ammoniated latex undergoes a progressive and marked thickening. In presence of ammonia and ammonium ions a zinc form zinc ammine complexes, having low stability constants and decomposes to form insoluble zinc soaps, leads to destabilization of latex. High ammonia latex, when deammoniated, the factory floor is polluted and there will be loss of rubber in the deammoniation tank. High ammonia latex, when used for dipping process, generally consumes more of coagulant. Because of the pungent nature, ammonia is difficult to handle.

When ammonia alone is used as bactericide, a small fraction of the total microbial population in latex attains resistance to ammonia. This can lead to gradual increase in VFA of high ammonia lattices. The formation of a surface skin is frequently a troublesome feature of high ammonia latex, when compounded.

4. CONCENTRATION OF LATEX

The concentration of latex means a process of increasing the total solid content of the system, with or without concurrent purification. Concentration is desirable in order to reduce transportation costs, or permit more efficient compounding, or to purify the product. The different methods for doing this may be classified below:

a) Concentration by evaporation :

There have been many prosses described in which evaporative methods are utilized. Among such methods vacuum evaporation, application of heat to latex in bulk or in attenuated films the use of air currents passing through or above the surface of heated latex, and many others. In this case potassium hydroxide and a potassium soap are added to latex and the same is concentrated by heat and air in an apparatus. The potassium hydroxide furnishes germicidal power due to its high P^{n}, and stability due to the formation of soaps from the fatty acid esters. The additional soap is to furnish further protection. If these materials were not used the long heat process would destroy the naturally occurring protein stabilizers and prevent a successful concentration to a stable product. This Latex concentrate appears on the market under the name of "Revertex" as a paste of from 70 to 80% total solids containing all of the non-rubber constituents originally present, besides the added fixed alkali and soap. This product, because of its high stability, can be utilized for mixing with large amounts of pigments, fillers and other compounding materials in process where quick setting must occur with a minimum of drying. On account of the high content of alkali and non rubber constituents, this type of product must be used with caution in rubber articles manufactured for wearing apparel, electrical insulation, weather resistant products or where an acid coagulation is desired.

It has been proposed to concentrate by rotating heated coils partially submerged in latex. In this way fresh surfaces of heated latex are repeatedly exposed to the air thereby promoting rapid concentration. There are also methods for concentrating by spraying or by a combination of spraying and reduced pressure.

b) Creaming

In discussing the conditioning of latex we are always confronted with the problem of non uniform concentration of solids throughout the mass. This necessitates proper stirring or agitation of the latex in order to overcome this slight tendency to cream. Such creaming is slow, and the changes that occur in commercial handling are not great except in the uppermost and lowermost layers of the latex. Creaming provides the removal of a large amount of water, thus lowering the freight charges and at the same time eliminating a large proportion of the non rubber constituents. It operates with any one of so many inexpensive creaming agents that it can be said that the cost of creaming per pound of rubber product is the lowest of any type of purified concentrate.

The main advantage of a cream concentrate are its relatively low initial cost, its ease of production, its high total solid content, its freedom from impurities, its uniform viscosity and its high mechanical and chemical stability. In addition to these advantages it must be pointed out that this method of concentration is used it is not necessary to rework the serum; in other words, a creaming process can be so operated as to cause practically no rubber loss in the serum, thus eliminating the necessity of crepe or sheet plants in the vicinity of the creaming plant.

c) Centrifuging:

Like chemical creaming, mechanical creaming or centrifuging takes advantage of the difference in density between the dispersed phase and the aqueous medium. In centrifuging we apply a force many times that due to the acceleration of gravity. In creaming we temporarily decrease the stability of the emulsion. Both processes eliminate water-soluble non rubber constituents, and in about the same are removed.

At the present time there are two efficient types of machine available the haval & the sharples type. The choice as to which one should be used will depend on the conditions to be met, that is, the age of the latex, its stability and the types of serum and concentrate desired.

The centrifuging depends upon the application of severe stress to accomplish the required result. This factor prevents practical separation in to a high rubber content cream and a rubber free serum. To effect such complete separation it would be necessary to maintain the latex in the machine for too great a time causing a decided loss in the stability of the product as well as a reduced output.

d) Filtration

Hopkinson & Gibbons described a means for removing water and non rubber constituents through porous membranes such as unglazed porcelain and the like. More recently these filtration methods have been refined so that in certain cases they are used commercially either to produce a purified concentrate or to produce a useful residuum of dried rubber. Except in special cases however it is believed the newer and more economical methods of chemical and mechanical methods of creaming will replace this earlier but more laborious method.

4. i Why concentration is necessary

The low DRC field latex, if employed in latex dipping process, the thickness of the deposit formed will be small. To obtain desired thickness, the number of dips will be more, compound to a high DRC latex. Also the strength of wet gel formed from a low DRC latex is poor. The cost of transportation of low DRC latex is high. These considerations make it necessary to concentrate field latex.

4. ii Applications of Natural Rubber Latex

a) Latex dipping process is employed for making wide range of rubber products such as various types of gloves, seamless football bladders, toy balloons and prophylactics.

b) A large number of products are made by latex moulding especially hollow castings.

c) Another application of this polymer lattices is in textiles. By the process of latex spreading, a coherent, impervious film of polymer over one surface of the textile is formed. The polymer lattices act as binder for non woven fabrics. Another use is in connection with carpet manufacture.

d) Latex adhesives are used in wide range of different industries. It is used in the binding of paper& leather.

e) Another application is in the field of engineering technology, that is in the manufacture of latex cement composition in surface of roads.

f) Latex is used in the sealing of cans for the preservation of food - stuffs used in the insulation of copper conductors and as stabilizers for sandy soils.

5. VFA FORMATION IN NATURAL RUBBER LATEX

Due to bacterial activity cause many changes in non rubber constituents and the degree of bacterial fermentation measured by the volatile fatty acid content (VFA NO.) is one of the most important tests of quality in natural latex. The extent of VFA formation in latex concentrate differs from that of field latex, but only in as far as there are differences in the level of ammonia in the water phase and a reduction in substrate.

The extra glucose added to ammoniated field latex or concentrate give rise to increase in VFA formation. The addition of glucose to latex gives an increase in VFA formation. This suggest that glucose is a substrate. Any substance which interferes with the formation of the complex will decrease the rate of VFA. The latex produced in the post wintering months show less VFA formation, while the pre-wintering months give maximum VFA formation.

The breakdown of latex protein during storage to give amino acids may be due to a gradual alkaline hydrolysis or to bacterial action. When the bacteria are activated VFA formation is "trigged off" and continues until the substrate is exhausted. Volatile fatty acids such as acetic acid affects the properties and quality of latex concentrate and the short chain volatile fatty acids could be determined by steam distillation of the serum from acid coagulated latex. The actual substrate for the production of VFA is not known but it is presumed to be the reducing sugars present in the serum, since it has been possible to obtain additional VFA formation by the addition of glucose. Reduction in substrate concentration will reduce the extend of VFA formation.

5.i SUBSTRATE FOR VOLATILE FATTY ACID FORMATION IN NATURAL RUBBER LATEX

Due to bacterial activity cause many changes in non-rubber constituents and the degree of bacterial fermentation measured by the volatile fatty acid content (VFA No.) of the latex has become one of the most important tests of quality in natural latex. The actual bacteria responsible for the breakdown of the non-rubber components of latex, are not definitely known; the Rubber Research Institute of Malay has suggested they are anerobic types while Lowe suggested the bacteria are micro aerobes, whose activity is trigged off by aeration of the latex during pumping and transportation. The highest count of true anaerobes obtained from latex concentrate during the course of these investigation was, in fact, the negligible quantity of three bacteria per ml latex.

The onset and extent of VFA formation in latex concentrate differs from that of field latex, but only in as far as there are differences in level of ammonia in the water phase and a reduction in substrate or serum volume during concentrate production.

The rate of formation of volatile acids was studied by Philpott and Sekhar and stated to be –

a) neglible in deammoniated latex from which the serum substances had been removed by multiple creaming.

b) normal in the same latex when reinforced with serum protein.

c) much enhanced in the same latex reinforced with whole serum, glucose or quebrachitol.

Although these observations were not supported by experimental data, Lowe confirmed that extra glucose added to ammoniated field latex or concentrate gave rise to increase in VFA formation. But if the breakdown of non-rubber constituents is to be controlled, then the substrate for VFA formation and the changes involved need to be much more clearly defined.

The addition of glucose to latex gives an increase in VFA formation and the pattern of formation with the initial lag phase before the onset of VFA formation is very similar to that of ordinary latex. This suggest glucose is substrate. Any substance which interferes with the formation of the complex will decrease the rate of VFA. The ceiling VFA number for latex will depend on the amount of glucose units present. The latex produced in the post wintering months shows markedly less VFA formation while the pre wintering months give maximum VFA formation.

The breakdown of latex protein during storage to give amino acid may be due to a gradual alkaline hydrolysis or to bacterial action. When fresh latex or concentrate is stored, no VFA formation would be possible until the glucose – amino acid substrate had been generated, and this is limited by the low initial level of amino acids which would explain the initial period of low VFA. Then when the bacteria are activated VFA formation is “trigged off” and continues until the substrate is exhausted.

Volatile acids accumulate in latex because of the lack of oxygen during normal storage and because of the ammonia used for preservation. By aerating latex, it is possible to allow the substrate to be oxidized away to carbon dioxide, but as some of the rubber is degraded this practice has no practical value. The alkaline nature of the latex prevents the production of other fermentation compounds such as lactic acid and alcohol is to be found in fresh un ammoniated field latex.

Ammonia preservation tends to inhibit the oxidation or regeneration of reduced diphosphopyridine nucleotide.

5. ii FORMATION OF VOLATILE FATTY ACID IN AMMONIA PRESERVED NATURAL LATEX CONCENTRATE

The quality of preservation of latex concentrate has been judged by the KOH number, the mechanical stability (MST) and by some specific conductivity tests. Volatile fatty acids such as acetic acid were affecting the properties and quality of latex concentrate, and that the short chain volatile fatty acids could be determined by steam distillation of the serum from acid coagulated latex. The rate and extent of VFA formation is much greater in the case of field latex. With latex concentrate, there is an initial stationary period when the VFA content remains close to the level obtained at the time of processing. The stationary phase ends abruptly with a sudden rise in VFA content. In the space of three or four days, this phase of VFA formation, to all intents, ceases and from then on there is a second stationary phase during which the VFA may climb very slowly. The formation of VFA is an enzymic process, and since VFA is most readily produced in poorly preserved field latex, the enzymes responsible are believed to be bacterial in origin.

CHAPTER II

II EXPERIMENTAL DETAILS

1. i Ingredients/ Chemicals used

0.8% ammonia, 0.5% glucose

1. ii Preparation of 0.5% glucose

10gm. Glucose accurately weighed and dissolved in 2 liters of latex.

1. iii Preparation of 0.8% ammonia

80 ml of 20% liquor ammonia is mixed with 2 liters of latex.

2. TEST METHODS

2.i Preparation of latex sample

Collect 2 litres of latex in four cans each. In the first can latex alone is stored. Second can containing 2 litres of latex is added with 10 gm. glucose and the third can of 2 litres latex is added with 80ml. (20%) ammonia. Finally 10 gm. glucose and 80 ml. (20%) ammonia is added together in the 2 liter latex.

2. ii Determination of total solid content (TS)

Take about 20 ml. of well mixed sample in a stoppered conical flask. Weighed to the nearest 0.01 gm. Poured about 2 gm. of sample into previously weighed petridish of about 60 mm diameter and weighed to obtain the weight of latex taken from the difference. Swirled the petridish gently to ensure that latex covered the bottom of the dish. Dried the test portion in an air oven at a temperature of 70^0 C for 16 hours. Cooled in a desicator and weighed as quickly as possible. Repeated the drying and weighing operation until the loss in weight is less than 1 gm between consecutive weighings when dried at temperature between $70\text{-}75^0$ C.

Calculation:

$$\text{TS \% by weight} = W_1/W_2 \times 100$$

Where W_1 = weight in gms of dried film

W_2 = weight in gms of sample taken for test.

2. iii Determination of Dry Rubber Contents (DRC)

Weighed about 15 gms of the well mixed latex sample (about 10 gm if it is concentrated latex) accurately to 1mg into a 250 ml beaker from stoppered conical flask. Added equal amount of water (for centrifuged latex double amount per gm). Added about 2 – 3ml of acetic acid per gm of sample with gentle stirring kept the solution undisturbed for about 15 minutes in a water bath till the serum is clear. Added about 5 ml of rectified spirit per gm of sample and gently stirred, if the serum was not clear on heating. When the serum is clear, filtered the serum through whatmann no. 1 filter paper. Collected any particles of coagulum by rubbing with main bulk. Thickness of coagulum is reduced to about 2 mm either by hand roller or other devices such as mechanical roller. Washed the coagulum with running water with at least 6 changes of water. Dried the coagulum at a temperature of approximately 70 plus or minus 2^0C cooled in desicator and weighed. Determination must be duplicated.

Calculation:

Dry Rubber Content (%) = $W_1/W_2 \times 100$
W_1 – weight of dried film
W_2 – weight in gm of latex sample taken.

2. iv Determination of volatile fatty acid number:

Weighed about 50 gm of latex of known DRC and TS into a beaker. Added 50 ml 30% $(NH_4)_2SO_4$ solution and stirred the mixture warming over a water bath until the latex thickened and coagulated. Pressed the serum out of the coagulum. 25 ml of the filtered serum was taken and acidified with 5 ml dilute sulphuric acid. Pipetted out 10 ml of the acidified serum into the inner tube of the Markham still and added 5 drops of silicon antifoaming agent. Washed with distilled water and closed.

Placed a 250 ml conical flask under the tip of the condenser to receive the distillate. Closed the steam outlet partially to divert the steam into the inner tube. Passed the steam gently at first, then closed the steam outlet fully. Continued distillation until 100 ml distillate was collected. Titrated the distillate with carbonate free 0.02 N Barium hydroxide using phenolphthalein as indicator till pink colour was obtained. A blank test was conducted by substituting 20 ml of water from the 50 gm of concentrated latex.

Titrated the distillate against std. 0.02N Barium hydroxide using phenolphthalein as indicator.

VFA number is calculated using the equation:

$$\text{VFA number} = \frac{561NV[50 + ((100 - DRC) \times 50/102)]}{50 \times 10 \times TS}$$

DRC = Dry Rubber Content
N = Normality of barium hydroxide
V = Volume of barium hydroxide
TS = Total Solid content

Effectiveness of Latex preservation

Effectiveness of latex preservation is judged by the volatile fatty acid (VFA) content in latex. VFA number of latex is the number of grams of potassium hydroxide needed to neutralize the volatile fatty acid anions present in a quantity of latex equivalent to 100 gm total solids.

CHAPTER III

III.i EXPERIMENTAL PART

A lot of 20 litres of natural latex, obtained from rubber plantation, was well homogenized by proper mixing. Its dry rubber content and total solid content were evaluated. The lot of latex was divided in to four portions and treated as follows:

a) No treatment – control

b) Latex mixed with glucose to the extent of 0.5% glucose was added as 10% solution.

c) Ammoniated to 0.8%. Ammonia was added as 20% aqueous solution.

d) Latex treated with 0.5% glucose and 0.8% ammonia.

VFA content of these lattices were evaluated periodically to study the effect of glucose on VFA generation and consequent coagulation of latex.

III.ii RESULTS AND DISCUSSION

The results on VFA determination is provided in table 1. The raw latex, immediately on collection had VFA number of 0.0547, but it coagulated after 24 hours. Subsequent VFA determinations could not be carried out.

Latex which was treated with glucose had initial VFA content of 0.0550, but it coagulated after 14 hours. One of the major factor leading to auto coagulation of field latex is volatile fatty acid generation in latex. Lowe has identified glucose as the substrate for VFA generation. The speedy coagulation of glucose treated latex suggests that the added glucose led to generation of acetic acid by bacterial activity.

Table. 1

Age of latex (days)	VFA Number			
	Latex alone	Latex with 0.5% glucose	Latex with 0.8% ammonia (●)	Latex with 0.5% glucose & 0.8% ammonia (▲)
0	0.0547	0.0550	0.0514	0.0526
1	coagulated after 24 hrs	coagulated after 14 hrs	0.05596	0.0610
3	-	-	0.0665	0.0738
11	-	-	0.10378	0.10922

Data on VFA development of well preserved ammoniated latex and also in presence of added glucose is provided in figure 1. The data shows that glucose treated latex has not coagulated even after 11 days, and its VFA increase over the ammoniated latex is very small. This observation suggests that even though glucose was present, it could not be acted by micro organisms, when the latex is well preserved with ammonia.

figure. 1

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Conclusions

Following conclusions are derived from this study:

i) Addition of glucose to unpreserved latex leads to its speedy coagulation.

ii) The activity of micro organisms on glucose in latex is not permitted in well preserved high ammonia field latex.