E-Learning
Module 1

Polymer Latex: Definition & Classification
NR latex: Origin, Tapping, Composition and its Properties

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What are Polymer Latex?

- Stable colloidal dispersion of a polymeric hydrocarbon particles dispersed in an aqueous medium (SERUM)

Two phase system
1) Continuous phase – Water
2) Discrete phase- Polymer particles
Polymer Latex Particle

Schematic representation of a rubber particle:
- Minerals salts in serum
- Proteins in serum
- Carbohydrates in serum
- Rubber hydrocarbon
- Rubbery membrane
- Lipid
- Phospholipid-protein complex
- Interface water

Proteins
Layer thickness ~ 20 nm
Long chain fatty acid soaps

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Classification of Polymer Latex

1. **Natural latices** ➔ *obtain from plants*

2. **Synthetic latices** ➔ *produced from emulsion polymerization process*

3. **Artificial latices** ➔ *produced by dispersing the appropriate bulk polymer in an aqueous dispersion medium*

4. **Modified latices** ➔ *produced by modification of existing type of latex (by grafting, crosslinking etc)*
Natural Rubber Latex

- *Hevea brasiliensis*, the Pará rubber tree is a flowering plant belonging to the family Euphorbiaceae.

- Rubber Tree height grows up to 25 to 30 metres having straight trunk and thick, somewhat soft, light brownish grey bark.

- An inner layer of soft bast, an intermediate layer of hard bast, and an outer protective layer of cork cells can be distinguished in the bark of the rubber tree.

- The vessels are concentrated in the soft bast arranged in a series of concentric rings of interconnecting vessels.
The main crop from a rubber plantation is latex, *a milky white dispersion of rubber in water*, which is harvested by the tapping process.

Two to three hours after tapping, the latex collected in the cup is transferred to a clean bucket. About 70-80 per cent of the crop from a rubber plantation is in the form of latex.

The latex which gets solidified in the tapping panel (tree lace) and the collection cups (cup lump) also form part of the crop and are collected by the tapper in a basket just prior to tapping.

The latex spilt and/or overflowed to the ground (earth scrap) when gets dried up is also collected as scrap once in a month. These are collectively called field coagulum.
Latex Tapping

- Latex is obtained from the bark of the rubber tree by tapping.
- Tapping is a process of controlled wounding during which thin shavings of bark is removed to cut open the latex vessels in the case of trees tapped for the first time or to remove the coagulum which blocks the cut ends of the latex vessels in the case of trees under regular tapping.
- Budded plants are regarded as tappable when they attain a girth of 50 cm (20 inch) at a height of 125 cm (50 inch) from the bud union.
- In a budded trees, subsequent panels are also opened at the same height i.e., 125 cm. The height specified for opening subsequent panels on a seedling tree is 100 cm.
- The latex vessels in the bark run at an angle of 3-50 to the right and therefore a cut from high left to low right will open greater number of latex vessels.
Tapping Systems

- **S**: One full spiral cut
- **V**: One full V-cut
- **S/2**: One-half spiral cut
- **S/4**: One-fourth spiral cut
- **2 X S/4**: Two one-fourth spiral cuts on the same tree
- **S/2 U**: One-half spiral cut tapped upwards
- **2 x S/2 DU**: Two half spiral cuts, one tapped upward and the other tapped downward
- **d1**: Daily tapping
- **d2**: Alternate daily tapping
- **d3**: Third daily
- **d2 6d/7**: Alternate daily, six days in tapping followed by one day rest.
Latex Tapping

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Yield Stimulant

- Certain chemicals can induce ethylene formation in the plant tissue while certain others can generate ethylene directly by decomposition.
- Ethephon containing \(2\text{-chloroethyl phosphonic acid}\) as active ingredient, is a very potent yield stimulant. In soil and plants, ethephon undergoes rapid degradation to phosphoric acid, ethylene and chloride ions and hence is a safe yield stimulant.
- Concentration of ethephon to be used is 2.5% for panel application and 5% for lace application. Months of application can be April/May, September and November.
- Latex and field coagulum are highly susceptible to bacterial action and therefore it is essential to add PRESERVATIVES for safe storage and marketing.
# Chemical Composition Of NR Latex

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber</td>
<td>30-40%</td>
</tr>
<tr>
<td>Resin</td>
<td>1-2%</td>
</tr>
<tr>
<td>Protein</td>
<td>2-2.5%</td>
</tr>
<tr>
<td>Sugar</td>
<td>1-1.5%</td>
</tr>
<tr>
<td>Ash</td>
<td>0.7-0.9%</td>
</tr>
<tr>
<td>Water</td>
<td>55-60%</td>
</tr>
</tbody>
</table>
NR Latex Structure

Polyisoprene Rubber

Proteins
Phospholipids

(A) Protein
Rubber
Phospholipid

(B) Top view of NR particle
Cross-section of NR particle
Latex Properties

- Fresh latex, as it comes out from the tree is slightly alkaline or neutral, pH 7 to 8
- Latex is a white or slightly yellowish opaque milky liquid with a specific gravity, which varies between 0.974 and 0.986.
- It is a weak lyophilic colloidal system of spherical or pear-shaped rubber globules (particle size less than 5 microns) suspended in an aqueous serum.
- The rubber globule is surrounded by a protective layer of proteins and phospholipids, which impart the lyophilic nature to latex.
- The stability of latex is due to the negative charge present on the protective layer. Also it contains a variety of non-rubber constituents both organic and inorganic, in addition to rubber.
- The proportion of these constituents may vary with clone, soil nutrition, climate etc.
Serum Constituents (aqueous medium)

- Inorganic salts (ca. 0.8%) : K (ca. 0.2%) and Mg (ca. 0.05%) as the chief cations and phosphate (ca. 0.4%) the chief anion.

- An abnormally high ratio of magnesium to phosphate ion often results in a low mechanical stability.

- Volatile fatty acids (acetic and formic acid) are formed in the serum if preservation of latex is delayed.

- Cu2+ > 10 ppm promote oxidative degradation of the rubber, storage stability and properties.
Particle Size and Colloidal Stability

- The rubber particles have size 50 A to about 10,000 A.
- (sometimes particles as big as 3 microns are also detected).
- A rubber particle of average size about 1000 A contains hundreds of molecules of the hydrocarbon and is surrounded by a surface film of proteins and lipids that offer colloidal stability.
- The protein envelope is about 100 A thick.
Stabilisation and Destabilisation of Latex

1. The negatively charged protein membrane surrounding the rubber molecules causes the rubber molecules to repel each other.
2. This condition causes natural rubber to remain in a liquid form and could not coagulate.

- When an acid is added, the hydrogen ions, $H^+$, neutralize the negative charges on the protein membrane.
Coagulation of Latex

Diagram of rubber particles

Figure: Coagulation process of latex
Spontaneous Coagulation

- Fresh NR latex becomes acidic rapidly due to bacterial action on exposed to sunlight and releases organic acids (lactic acids) neutralizes the negative charge on rubber particles and the latex gradually gets coagulated on keeping. Therefore, fresh latex cannot be kept for long without preservative treatment.

- Latex can be processed into any of the following forms:
  - Preserved field latex and latex concentrate
  - Sheet rubber
  - Block rubber
  - Crepe rubber
  - Field coagulum can be processed only into crepe rubber or block rubber.
Books

- High Polymer Lattices, Vol 1 & 2, D.C. Blackely
- Natural Rubber Handbook, RRJII, Kotayam
- Polymer Latex and its application, K.A. Culvert