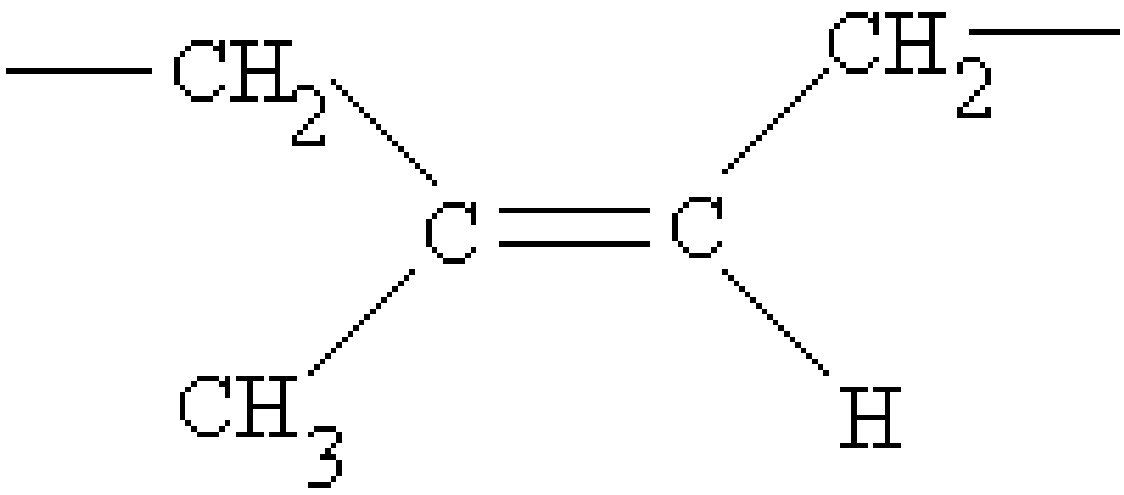
Polyiisoprene

Ntural Rubber

Natural rubber

- Introduction
- Basically, natural rubber consists of cis-1,4-polyisoprene. The commercial product has, along with polyisoprene, other components (proteins, phosphatides, mineral salts, etc.) that represent 6-8% of the product. Some of these impurities have a beneficial effect; can, for example, act as natural antioxidants.

Polyisoprene



Isopreno

Polyisoprene

- There are many plant species that produce rubber, but virtually all natural rubber used industrially comes from the Hevea Brasiliensis tree, originally from the Amazon rainforest and later cultivated on plantations in Southeast Asia and equatorial Africa. Propagation is carried out using the technique of grafting or cloning, ensuring that the entire plantation or a good part of it derives from a single plant.

Obtaining methods and commercial types R

- Rubber is found in the Hevea tree in the form of a colloidal suspension with a milky appearance, called latex, which has 30% rubber. The latex circulates through a network of lactiferous channels from which it is extracted through an incision (bleeding) in the bark that surrounds these channels, which causes the secretion of latex for a few hours, until, due to spontaneous coagulation, the incision is closed; the incision must be redone in order for the process to be repeated, but this operation must be done on alternate days.

Obtaining methods and commercial types R

- The latex that flows from the incision is collected in properly disposed containers, the bleeding is done in the early hours of the morning and, at the end of the day, the latex accumulated in the container is collected. Before making a new incision, the existing clot is collected in the vessels, formed by the evaporation of the residual latex from the previous operation (known as the bottom of the vessel - in English cum lump) and the clot strip formed on the previous incision (called tree-lace or sernamby).

Obtaining methods and commercial types R

- The collected latex is taken to a unit where it is homogenized in large storage tanks, and then, by adding diluted acetic or formic acid, the latex is coagulated into 4-5 cm thick plates.

Traditional business types

- The plates are successively washed and laminated between cylinders; gradually, these cylinders reduce the thickness of the plate and eliminate residual water; the last pair of cylinders are grooved, so that the rubber has a rough surface, facilitating the subsequent drying of the board. Drying is done by various processes, with moderately hot air and heltered from light (Air Dried Sheet or ADS) or, more often, by smoke from combustion wood (Smoked Sheet or RSS, Ribbed Smoked Sheet), which is darker in color than ADS

Traditional business types

- Another alternative is the manufacture of white or pale crepe (Pale Crepe). In this process, partial coagulation is carried out under controlled conditions, so that only the so-called yellow fraction, consisting mainly of lutoids responsible for the color of the latex, is separated from the rest of the latex, which will then be coagulated with the addition of more acid. The clot is dried at room temperature and protected from light.

Traditional business types

- A similar treatment to the one used to obtain the pale crepe is also applied to the clots collected as a by-product (bottom of a vessel, tree-laces, etc) and we obtain the brown crepes (Brown Crepes)
- The classification of these types of natural rubber is made by comparison in terms of color, presence and frequency of impurities, mold, etc. with the standards described in the International Quality and Packaging Standards for types of Natural Rubber, better known as the Green Book.

Technically Specified Rubber

- Although many use the Green Book as a standard, other standards were developed to control the quality of natural rubber: in 1965 the System was introduced in the market Standard Malaysian Rubber or SMR (Standard Malaysian Rubber), a procedure that was followed by other producing countries, until the International Organization for Standardization, ISO, issued the ISO 2000 standard for the so-called TSR (Technically Specified Rubber) rubbers .

Technically Specified Rubber

- The characteristics controlled by TSR rubbers are:
- **the content of impurities**, in the sense of foreign bodies, such as grains of sand, usks, etc
- **ash and nitrogen content;**
- **volatile matter content**;
- **plasticity retention index or PRI (Plasticity Retention Index)**; in some
- types, **the coloring**

Formulations

- Due to the activating effect of the methyl group on the reactivity of the double bond of the polyisoprene chain, natural rubber can be vulcanized with virtually all known vulcanizing agents.

Formulations

- In the case of sulfur vulcanization, the most common, it presents a relatively high vulcanization speed. Doses of vulcanizing ingredients depend on their nature and processing conditions:
- 2-3 parts sulfur, 0.4-1 part accelerators, 4-5 parts zinc oxide and 2-3 parts stearic acid are common. The only inconvenience is the strong tendency to reversal, which is verified by a decrease in hardness and mechanical resistance, when surpassing the vulcanization plateau; this trend can be the cause of problems in the injection or continuous vulcanization of extruded profiles, or when the greater thickness of the part requires the use of long vulcanization times. In this case, we resort to the so-called EV (Efficient Vulcanization) vulcanizing systems , characterized by low doses of sulfur, 2.0-5.0 parts, complemented by a sulfur donor and a high dose of accelerators, 3-5 parts. With these systems, the

Formulations

- Crossing bridges are basically monosulfidic or disulfidic, thermally more stable than polysulfidic ones. Thus, the vulcanizates are better able to resist an eventual excess of vulcanization, as well as having better resistance to thermal aging. Another solution is the use of a semi-EV system, with medium doses of sulfur and accelerators.

Formulations

- Natural rubber, like other rubbers that crystallize under stress, has good mechanical resistance and does not require fillers; for this reason, they are used to make the formulation cheaper and to improve resistance to abrasion and tearing. Both reinforcing fillers and fillers in moderate proportions contribute to facilitate the processing of compounds, mainly in extrusion and calendering

Formulations

- Natural rubber is miscible with other general purpose rubbers (IR, SBR, BR) and with special rubbers (NBR, CR, XIIR, EPDM, etc.), which allows us to combine properties between different polymers; only saturated (EPM) or slightly unsaturated (IIR) rubbers have compatibility issues.
- The viscosity of natural rubber is reduced by chewing; thus, plasticizers are not as necessary as in synthetic rubbers, but they are often used to facilitate and improve the dispersion of fillers

Processing

- The first operation in the preparation of any NR compound is to carry out the mastication process, to reduce its initial high viscosity, enabling the incorporation of the other ingredients.
- Since 1939, it has been experimentally known that chewing carried out at temperatures of 100-115°C offers the best solution to the viscosity problem; it is believed that there is an oxidation process involved, as chewing experiments carried out in an inert atmosphere had no effect.

Processing

- In practice, mastication is carried out in internal mixers at elevated temperatures and often in the presence of **a peptizer**, which basically catalyzes the oxidation process.
- If the process is carried out in a cylinder mixer, the temperature must remain at 70°C. The use of TSR-type rubbers reduces or even eliminates this step.

Processing

- Once the viscosity is reduced, the preparation of the compound does not present any problems, since the high nerve of the natural rubber ensures the existence of the necessary shear forces for the adequate dispersion of the loads.
- In the press molding stages, the only problem is the tendency of reversal due to excessive vulcanization; the selection of an adequate vulcanizing system and vulcanization conditions solve this inconvenience, but in special cases we must resort to high frequency preheating, mainly in thick artifacts

Processing

- pecial cases we must resort to high frequency preheating, mainly in thick artifacts
- In extrusion and calendering operations in compounds with moderate loads, it does not present processing problems

Properties and Applications

- One of the main characteristics that gives natural rubber its properties, and is a consequence of its structural regularity, is its tendency to crystallization. Crystallization occurs when the NR undergoes some type of deformation or temperature reduction, making the product more rigid and harder. Its maximum and spontaneous crystallization occurs at -26ºC and is a totally reversible process, requiring only a slight heating
- This phenomenon is less accentuated in vulcanizates

Properties and Applications

- Abrasion resistance depends a lot on the type of service: for example, in tires, due to the type of service, abrasion is lower than SBR; however, in mining hoses its behavior is superior.
- Its main use is in large tires, such as tractor and truck tires, aircraft and racing car tires, mining hoses, etc

Bibliography

- 1. HOFMANN, W, Rubber Technology Handbook, Hanser Publishers, Munich, 1989
- 2. M. Morton, Rubber Technology (3rd ed. 1987).