Lecture No. (2)

History of Rubber Materials

Introduction of Rubber

The rubbers (elastomeric) materials can be classified into two major types according to common use are natural rubber and synthetic rubber.

Natural rubber (NR) is exhibit many outstanding properties, such as good oil resistance, low gas permeability, improved rolling resistance, high strength, resilience, elasticity, resistance to abrasion, low cost, and efficient heat dispersion makes it ideal for use in medical and other application.

Many countries developing because the important of natural rubber in the social and economic life and became the first demand of a product in world rubber such as India, Nigeria and Brazil. Also many industrial developing in transportation (car tires) and sport field. That led to many researches have been made to improve the rubber product that used in this field.

During the (1914 to 1940) natural rubber demand had risen for car tire industry, while the forecasted production of natural rubber from all world countries for other uses about (12.5 million tons), and the forecasted consumption (13.6 million tons). Expected a production capacity of rubber in 2020 about (680 million tons). Asia supplies of natural rubber with over 90% that represents the world's largest natural rubber producer, which is based on advantages in terms of available land and labor.

The drop in natural rubber product and product of synthetic rubber can be attributed to the discovery of crude oil, uneconomic size of farmer's holdings, old age of plantations, little agricultural inputs like fertilizer, not found availability for credit facilities, and pesticides, also less and high cost of labor in many rubber producing areas.

Several types of synthetic rubber were made such as styrene butadiene rubber SBR, nitrile rubber NBR, butyl rubber IIR, butadiene rubber BR, …etc. The SBR and BR varieties are the most widely consumed type of synthetic rubber.

History of Natural Rubber (NR)

The history of rubber dates back to the 1525 in the peoples America, and the first known elastomer was natural rubber (NR), were used as rubber balls that use for mortar. In 1615, the first practical use of rubber in the waterproofing footwear, when peoples of South America extracted this substance from trees often called "Hevea Brasiliensis" and "Para Rubber" trees, meaning "weeping wood", these trees represents sources of natural rubber, that begin grew in the Amazon forests this is lead to Amazonas becomes the economic heart of Brazil.

During the middle of the 18th century to about the end of 20th century, the rubber industry development. And most rubber tree plantation grew in Southeast Asia (Thailand, Malaysia, India, China and Indonesia), also rubber tree are grew in Africa such as Nigeria, which became important producers of natural rubber. The difference between rubber production techniques in Brazil Africa and Asia, lead to the development and increase in productivity.

The history of natural rubber in Europeans began from the second half of the 19^{th} century, when increasing demand of the natural rubber. In 1820, British industrialist produced rubber and attempted to use them in clothing. The first bicycle tire product in 1830, while in 1832, the first factory was set up rubber product. At some time the America was used rubber in automobiles, electric light, waterproof clothing, footwear and snow-boots.

The major problem of rubber in warm weather rubber becomes sticky and in cold weather it became brittle. Charles Goodyear (in England) and Hancock (in America) simultaneously discovered the vulcanization procedure about 1839 by accident, which was the revolution for rubber industry; the vulcanization changed the nature of rubber, when heat treating rubber with sulphur. In 1845, R.W. Thomson invented the pneumatic tire and the inner tube, in 1869 made the solid rubber balls and hollow rubber balls for the golf and tennis, and in 1888, first use of rubber to form of rain jackets.

History of Synthetic Rubber

Synthetic rubber is any type of artificially that made by human from petroleum derivatives and petrochemical feedstock or polymer material is normally obtained by addition polymerization and condensation polymerization, which acts as an elastomer. Several types of synthetic rubber were made for some purposes of natural rubber and they are better than of it, but for others not as good.

The first synthetic rubber had been known since 1875, it's expensive, although the structure of it is difference from natural rubber. The drop in natural rubber production in Brazil at First World War about (1914-1918), lead to need for lower cost with stability products for manufacture tires, this was show SBR rubber, which is represented the massive development of the synthetic rubber industry, this product could be vulcanized easily, good costs, good properties and became the important of rubber industry.

During Second World War, in 1941, the USA required high natural rubber production, such as wire that used in factory, home, office and military facilities such as warships and tanks. At same time there were not enough raw materials to produce synthetic rubber by many different ways, this is pushed chemists and engineers from Russians and the Germans to discovering its chemical composition because the importance of the rubber industry since it first appeared and industrialize many synthetic rubbers. This was the reason to development of the synthetic rubber industry, compete with natural rubber and producing elastomers. Finally, the total output of synthetic rubber over 800,000 tons of rubber products.

Many researches done to develop the synthetic rubber performance in engineering application by enhancing the physical and mechanical properties. Synthetic rubber useful for different application such as car tires, footwear, civil, and medical materials, due to the synthetic rubbers have various properties.

Extraction of Natural Rubber

Natural rubber is thermoplastic polymer and represented not more than type of condensed resinous oil, it is usually extracted as solid product through

collection and coagulating of the rubber latex (rubber raw material) that obtained from the rubber tree when is cutting, but only a few produce sufficient quantities of a quality rubber.

Currently, most of natural rubber latex is derived usually from the (Hevea Brasiliensis) or (Para Rubber) trees which are a commercial and economically tree grown in plantations of Amazon forests or grown in areas with similar conditions to the Amazon. These types of trees are a quick-growing to exceed 25 m in height, branchless for 10 m, and least diameter 50 cm with smooth bark surface, this tree a period of time of not less than five years to become able to give production.

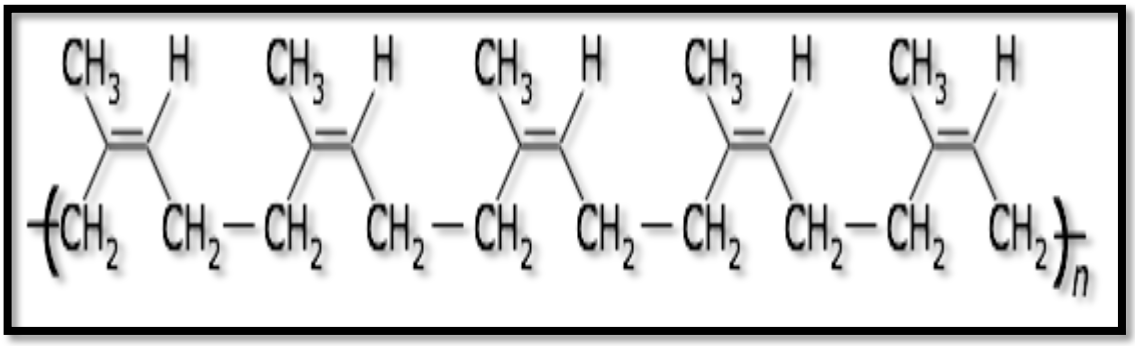
The rubber tapping process is the process which natural rubber latex is collected from crack by peeling thin tree layer from any part of plants (bark, roots, leaves, stems, and fruits), by using a special knife or harvesters to make cracks across the latex vessel, with deep enough without damaging the growing layer, or harming the growth or health of the tree and the tree wound later heals itself. The latex drop from the cut and a collected in small containers as liquid for a several hours until flow stop, this process as shown in (Figure 2). Finally,it is filled in tanks large cars are moving to factories to be synthesized to rubber raw material.

(Figure 2): Typical Rubber Plantation.

Description of Rubber Latex Structure

The rubber latex contains not only rubber particles but also non-rubber particles (such as protein) that dispersed in water. The ratio of rubber to non-rubber components varies from source to source.

The natural rubber structure is non-crystalline and high elasticity, also contains more than 99% of double bonds. And consists of repeated isoprene units $(C_5H_8)n$ as shown in (Figure 3), the polymerization of isoprene monomer with a small percentage of impurities to formation repeating alkene double bond in the linked rubber chain. The rubber latex components consist of more than 98% of cis 1, 4 polyisoprene and less than 2 % of trans 1, 4 polyisoprene.



(Figure 3): Cis 1, 4 Polyisoprene Units $(C_5H_8)n$ in Natural Rubber.

Rubber Latex Coagulation Methods

After collection the latex, must be taken to a processing plant, the rubber latex is not utilized in its original due to it have high water content about (70 %) of rubber latex and contain extraneous materials, sand or impurities. Therefore, it may be sieved to remove these materials during latex coagulation process which occur by mixing the rubber latex with some materials such as (dilute acetic acid, formic acid, and alum), to reduce the pH, promote coagulation and increase the speed of it by increasing the effectiveness of bacteria that help clotting biological of it, then rolled into rubber sheets, and dried in smokehouses.

Alternatively, after latex coagulation process, it may be washed, then cutter, and granulated under controlled conditions before being dried in bed driers to form a block rubber.