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Ribbed Smoked Rubber Sheet Production – A Review

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Abstract: Latex from rubber trees can be concentrated for production of carpet underlay, balloons, condoms e.t.c. or either process for production of smoked sheet that is used in manufacturing of tyres, footwear's, bridge pad and building foundation (to prevent earth quake). Production of smoked rubber sheet starts from the transportation of field latex to the processing centre, where the latex DRC is determined (using quick but approximate method "Metrolac Method") to know the quantity of water to standardise the latex as well as the volume of coagulant to be added using standard equations provided in this paper. The coagulated slab is then machined into ribbed sheet and allowed to dripped dry in air for four hours before charging into the smoked house for drying. The smoked dried sheets are sorts into grades and packages for sale. The demand for ribbed smoked rubber sheets (RSS) is higher in production of automobile tyres.

Keywords: Ribbed, Smoked, Rubber, Sheet

1. Introduction

Natural Rubber tree (*Hevea Brasiliensis*) is a latex producing tree belongs to a member of the spurge family, it responds to wounding by producing more latex. The economic life period of rubber tree in plantation is around 32 years of 7 years of immature phase and about 25 years of productive phase. Natural rubber is an economic tree crop in Nigeria and has diversity of uses which include provision of raw materials for agro-based industries, foreign exchange earnings and offers employment to a sizeable segment of the Nigerian farming rural population [1]. Tyre industry is the major consumer of natural rubber. It is well suited for the manufacture of tyre especially radial, heavy duty and high-speed tyres because of its dynamic qualities such as good tear strength and low heat build-up. Beyond the use of rubber for manufacture of tyres, rubber is used for the manufacture of specific products such as flexible oil resistance pipelines for offshore oil fields, inner tubes of tyres, footwear, bridge pad and building foundation in Earthquake prone areas. Latex concentrate is used for the production of carpet underlay, adhesives, foam, balloons, condoms, and medical accessories such as gloves and catheters. Rubber wood is used for furniture, particleboards and fuel [2, 3].

It has been estimated that about 18 million hectares of land is suitable for the cultivation of natural rubber in Nigeria. The country has about 247,000 hectares of land under natural rubber cultivation; however, only about 154,000 ha are under tapping. Small holding (usually 1 - 5 ha) account for between 75 – 85% of the total land area planted to rubber while the remaining percentage held by the Estate plantation [3, 10]. Annual total production is 95,000 metric tons; while about 60,000 metric tons is exported leaving a balance of 35,000 metric tons for local consumption. The design and operation of buildings for the drying and smoking of rubber has attracted considerable attention in the last few years. Several smoke-houses which show improvements in the case of handling the rubber, reductions in the time required to dry it, and a minimised risk of fire, have been designed [8, 9]. However improvements can be made from investigated characteristics of the drying process. This review work gives details of Ribbed Smoked Sheet production, applications or economic values to the nation and natural rubber growing farmers.

2. Ribbed Smoked Rubber Sheet Processing

2.1. Processing of Latex into Sheet

The rubber latex is collected through tapping of the rubber trees. This is done with high hygienic practice. The collection cups should be cleaned and free of water. Latex collected from the field is brought to the processing section where the sheeting battery is installed and the following procedures then followed:

Sieve the field latex through a 60 mm to 40 mm mesh to ensure clean latex free of dirt.

Determine the DRC using quick but approximate method called Metrolac Method

Calculate quantity of water for diluting the latex using equation 1

Calculate volume of acid require to coagulate the mixture using equation 2

$$\text{Quantity of water} =$$

$$\frac{\text{Vol.of latex (litre)} \times \text{DRC}}{12.5} - \text{Volume of latex} \quad (1)$$

$$\text{Vol. of acid required} = 0.5 \times \text{Quantity of water} \quad (2)$$

The latex is coagulated with coagulant (formic or Acetic acid), before the coagulation set in, aluminum partitions are inserted vertically in slots in the coagulating tank or a single unit of coagulation pan of 4 litres capacity. The rubber is stored for few hours; the soft thick gelatinous slabs are compressed by passage through rollers to remove water and produced sheets. The last pairs of roller are grooved and thus produce criss-cross rib characteristic marking on the sheet that increase the surface area and facilitates drying.

The rubber sheet is washed manually in a pool of water or with machine before charging into the smoking room where they are dried and cured for days depending on the moisture, thickness and season.

2.2. Process of Determining the DRC

Get one part of latex and add two parts of water. Put one part

of the mixture into a container and gently lower the Metrolac into the mixture. Allow the Metrolac to be in a stable position before taking the readings. After taken the reading, the figure is converted to Kg dry of rubber content using below equation.

$$\text{DRC in (Kg)} = \frac{\text{metrolac reading} \times 3}{1000} \quad (3)$$

Multiply equation 1 by 100, it gives dry rubber content in percentage.

$$\text{DRC in percentage} = (\text{metrolac reading} \times 0.3)\% \quad (4)$$

2.3. Smoking of the Ribbed Rubber Sheet

The firewood is burnt at a high combustion rate to bring up the room temperature to about 40 – 50°C while all the window, doors and ventilation windows ports remained open. When the room temperature reached 50°C, all the openings will be closed and burning continues to keep the temperature in the room at about 70°C, the process continues until the rubber sheets are dried and cured.

Smoked Rubber Sheet (SRS) is a solid form of rubber product. Hot air and smoke obtained from wood burning are used to cure the rubber sheets in smoking room. The smoke acts as a disinfectant which renders the rubber sheet less liable to mould attack [8].

3. Defects in Smoked Sheets and Applications of Smoked Sheets

3.1. Defects in Smoked Sheets

Quality of Natural Rubber (NR) in the world is progressively declined; the declining trend can be attributed to several reasons such as non-availability of skilled workforce in the rubber value chain (tappers, processor, and graders e.t.c). RSS sheets are often left to dry on the road side and in the open collecting dust, grit and external matter. Technically, improper smoke house for drying of rubber sheets leads to inconsistent quality, lack of adoption of technology and best practices [5]. Major defects and preventions are therefore presented in table 1.

Table 1. Ribbed Smoke Sheet Defects, Causes and Prevention

Defects	Causes	Prevention
Small sand dirt, or foreign particles in the sheet	Improper bulking and sieving	Proper bulking in suitable tanks for the sedimentation of the dirt and use proper sieve
Pinhead bubbles in cluster all over the sheets	Bacteria growth	The latex tanks and coagulation pan should be cleaned regularly preferably with a small quantity of disinfectant solution (Lysol or formalin)
Small bubbles along the edges of rubber sheets	Insufficient mixing of the acid with latex and	Ensure thorough mixing of acid with latex and use adequate quantity of acid for coagulation.
Small white specks and irregular bubbles	Insufficient acid for coagulation	
Blisters and large bubbles	Precoagulation of the latex	Use anticoagulation in the field
Burnt and oxidized sheets	Rapid drying in the smoke house	Gradual drying by regulating the drying temperature
Weak sheets	High drying temperature and direct flame on the sheet.	Regulate and monitored drying temperature.
Mould	High dilution of field latex, sheeting before maturation	Dilute latex rubber sheets to 12.5% DRC and sheeting should be done after the coagulum has obtained sufficient strength
Rust	Improper drying and storage under moist conditions	Dry the sheet after dipping in paranitrophenol solution
	Improper washing of the coagulum during and after sheeting	Wash the coagulum before and after sheeting

Defects	Causes	Prevention
Stickiness	High dosage of coagulant and high drying temperature	Use sufficient acid for coagulation and dry at the specific temperature.
Discoloration	Atmospheric oxidation during coagulation	Use sodium bisulphate solution before coagulation

Source: National Science Foundation

3.2. Uses / Applications of Smoked Rubber Sheet

Ribbed smoked sheets are used in the industrial sector when extra tough rubber is needed (for example, for tank liners). Pale Crepe is valuable for medical sundries, footwear, cements and adhesives, and engineering such as automobile tyres, re-treading materials and all other general products.

i. Gaskets

A rubber gasket is a mechanical seal that serves to fill the space between two objects, generally to prevent leakage between the two objects while under compression. Gaskets are commonly produced by cutting from rubber sheet materials, such as Neoprene, EPDM, or Silicones (CG, PG, TR, FDA). It is usually desirable that the gasket be made from a compressible or slightly compressible material such that it tightly fills the space it is designed for, including any slight irregularities.

ii. Rubber Seals

A mechanical rubber seal is a device which helps join systems or mechanisms together by preventing leakage (e.g., in a plumbing system), containing pressure, or excluding contamination.

iii. Rubber Curtains & Flaps

In mechanics a flap is any hinged plate often used as a cover or a simple one-way valve. Rubber flaps or curtains can serve as flexible screen and buffer areas from undesirable dust and particles. Flaps and curtains serve to protect and manage air or material movement in mechanical systems.

iv. Protective Surfacing

Rubber surfacing is used to protect commercial equipment from aesthetic or comprehensive damage. Removal pads and covers serve to separate the device from the operator, other moving parts or the environment [7, 10].

4. Discussions

Demand for ribbed smoked sheet for automotives tyres as elastomer is due to its high tensile strength, low heat build – up and resilience. Two types of sheets are popular in the international market, these are; Air Dried Sheets (ADS). Ribbed Smoked Sheets (RSS). Ribbed smoked sheets are among the most popular and oldest forms of natural rubber. The surface of the ribbed smoked sheet consists of crisscross rib marking, thereby the name ribbed smoked sheet.

The demand for tyres increases in tandem, leading to increases in consumption of RSS. Demand in North America, Japan, Europe and Asia – Pacific Region are expected to drive growth in future. China and India are expected to dominate the market in coming years in term of RSS consumption. Demand for RSS and price are influenced by

political stability, macro-economic fundamental, weather conditions, inflation, crude oil prices interest rates and government policies.

In the global marketplace today, we have the following major players; GMG Global LTD, Kaula Lumper Kepong Berhad, PT Bakrie Sumatera, Stri Tang Agro – Industry Public Company Ltd, Thai Hua Rubber plc, Titi Latex Sdu Bhd, Tong Thai Rubber, Von Bundit Co. Ltd and Watap Thailand Co Ltd. Global consumption of RSS therefore projected to reach 5.6 million metric tons by 2018 [4]. Ribbed rubber sheet varies according to the grades, according to Forbes and Walker Commodity Brokers (Pvt) Ltd.

To meet high demand of RSS, several factors are to be put into consideration, such as production capacity, input and processing costs, price differential with synthetic rubber and technological changes. Currently, china is the largest consumer of RSS in the world, it depends on imports to meet demand with about 70% of demand been met through imports.

The drying/ smoked house structure should be made of materials with poor heat conducting properties such as brick to reduce fuel usage and as well the drying time. Also, chimney should be provided to take away heavy smoke and water vapour that can affect the golden colour expected. Putting all these operating conditions into consideration, Nigeria will be able to compete with other RSS producing countries and enhances the nation income.

5. Conclusion

If the rubber producing farmers can add value to their product (latex) by producing ribbed smoked sheet in large quantity, it will geometrically increase their income and as well contribute positively to the nation's economic. Apart from the solid fuel (fire wood) that generates a lot of smoke that affect the quality of the sheets produced, biofuels and other renewable energy (such as biomass, biogas and solar energy) can be used to assist the rubber smoking system. Also in addition to ways of reducing fuel usage, farmers should be educated and encouraged on the use of heat resistance structures.

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