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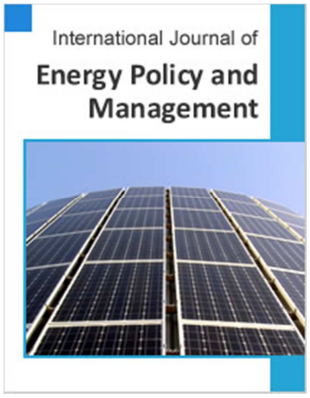

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Performance Evaluation of Locally Fabricated Drying Cabinet for Ribbed Smoked Sheet Production

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Abstract

Natural rubber latex can be processed into different forms through many technologies such as centrifugation, creaming, and sheeting. Sheeting of rubber latex involve collection of field latex, filtration, dilution of the field latex to a workable Dry Rubber Content, coagulation of the latex using formic or acetic acid as coagulant, sheeting into sheets and drying in open air under sun or Smoke House. A prototype Drying cabinet was locally fabricated from metal sheet grade GN8 - EN which has oven insulator, smoking chamber, insulated wall, and smoke separator base as components. It was insulated to prevent excessive heat loss to the surrounding. The outside temperatures of the system remain constant for up to an hour before experiencing infinitesimal drop during evaluation. The performance graph also shown that, the temperature increases linearly but gently along the slope. This result implies that, the system has a greater efficiency for smoking rubber sheet. Finally, the sheet produced were defects free up to 90% at a reduced production cost and drying time.

1. Introduction

The rubber plantation mainly consists of a species Hevea, Brasiliens commonly known as the rubber tree, is a tall erect tree with a straight trunk and bark which is usually fairly smooth and grey in color. Depending on the condition, the rubber tree takes 5-10 yrs to reach maturity i.e. the stage when tapping is started. The rubber production fluctuates between months and it is normally low during the rainy season, and these seasonal variations are important factors influencing markets [Olapade and Salawu, 1985].

Natural rubber has excellent elasticity, resilience, and toughness properties, and it is therefore a major constituent of many products used in the transportation, industrial, consumer, hygienic and medical sectors. Out of these major end-use markets for rubber, transportation is by far the largest single sector, with tyres and tyre products accounting alone for over 50% of natural rubber consumption. Truck and bus tyres would represent the largest single outlet for natural rubber, followed by automobile tyres [John and Peter, 2015].

Rubber tyres are of two types: solid (or cushion) tyres, in which the rubber portion

functions to carry the load and absorb shocks; and pneumatic tires, with compressed other than railroad cars). Pneumatic tyres include tyres for automobiles, trucks and buses, (motor) bicycles and airplanes and "off-the-road" tyres for special vehicles (such as construction vehicles and agricultural machinery). The distribution channel for pneumatic and solid tyres is two-tyred, consisting of original equipment manufacturers (OEMs) and the replacement market air that fills the tyre. The former are used on industrial machinery and on military vehicles; pneumatic tyres are used for almost all free-moving vehicles.

Ribbed smoked rubber sheet production and quality in the world is progressively declining, the declining trend can be attributed to several reasons such as non – availability of skilled workforce in the rubber value chain (tappers, processors, graders and so on). Ribbed smoked rubber sheet are sometimes left outside to dry and in the open collecting dust, grit, and external matter. Technically, improper smoke house for drying of rubber sheets leads to inconsistent quality and lack of adoption of this technology [Research and Market, 2015]. Ribbed smoked rubber sheet are graded and classified by visual comparison methods. Generally, must be well dried, clean, and strong. Ribbed smoked rubber sheets (RSS) are graded into RSS IX, RSS1, RSS2, RSS3, RSS4, and RSS5. Grade RSS IX, RSS1, RSS2, and RSS3 are transparent, while RSS4 and RSS5 are opaque sheets [Rubber Act, 2006; National Science Foundation, 2015]. Ribbed smoked sheets are used in the industrial sector when extra tough rubber is needed (for example, 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 like Gaskets, Rubber Seals, Rubber Curtains & Flaps Slitting Services, Protective Surfacing. [coirmat.com, 2013; [UNCTAD Secretariat, 2013].

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. 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 [Global industry analysts, inc., http//www.strategyR.com, 2015; Suttisak and Sirichai, 2015; Prasertsan et. al, 2015].

Therefore, the main objectives of this project is to locally develop an economical smoking cabinet prototype for smoking/drying of rubber sheet with the following sub-objectives: to design and fabricate smoking cabinet, to produce a local oven insulator from termite hill and to evaluate the performance of the system on drying time, fuel consumptions, and quality of the sheet produced.

2. Materials and Methodology

Processing of Field Latex

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. In the processing unit the following materials are needed; Lohashilpi Machine, source of clean Water, Electrical Source, Coagulation Pans, Hangers, Mixing Bowls, Formic Acid and Measuring Cylinder, Sieve (60 mm), Stirrer, Cups, Metrolac, Personnel Protective Wears.

Latex collected from the field is brought to the processing section where the sheeting battery is installed and the following procedures are followed:

a. Sieve the field latex through a 60 mm to 40 mm mesh to ensure clean latex free of dirt.
b. Determine the DRC using quick but approximate method called Metrolac Method

Process of Determine the DRC

Get one part of latex and add two parts of water. Measure one part of the mixture into a Metrolac Jar 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.

$$DRC\ in\ (Kg) = \frac{metrolac\ reading \times 3}{1000} \quad (1)$$

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

$$DRC\ in\ percentage = (metrolac\ reading\ \times 0.3)\% \quad (2)$$

Sheeting and Drying

The processed fielsd latex in the coagulation pan is left for a day to coagulate and mature for sheeing into ribbedd rubber sheet. the slab is passed through sets or rollers in the Lohashilpi machine and comes out as a Ribbed Sheet. The ribbed shheets are allowed to dry in the air for four hours before charging into thesmoke house for smoking and drying. The product from the smoke house is called Ribbed Smoked Sheet (RSS). The Ribbed on the sheet aids even drying while the smoke prevents mould growing on the sheet.

3. Result and Findings

Inside and Outside Temperatures with Time

When the system was fired for 30 minutes using 8 kg of rubber wood that has heating value of 13, 000 KJ/Kg, the inside temperature was found to be 150°C, the door of the system is opened to allow the temperature to drop to 80°C. The result for the inside temperature along with the outside temperature of the wall is summarized in table 1 and table 2 for Day 1 and 2 respectively.

a. Day 1 –

Table 1. *Inside and Outside Temperatures of the System with Time for Day 1.*

Hour	IT	OTS W	OTBW
11:05 am	80	38	38
11:20 am	80	38	38
11:30 am	78	38	38
11:40 am	75	40	41
11:50 am	78	40	41
12:10 pm	75	43	44
12:20 pm	75	43	46
12:40 pm	70	43	46
01:00 pm	68	46	46
01:20 pm	68	49	51
01:40 pm	68	50	51
02:00 pm	68	50	51
02:40 pm	68	50	53
3:00 pm	68	50	54

Source: Data Analysis

Table 2. *Inside and Outside Temperatures of the System with Time for Day 2.*

Hour	IT	OTSW	OTBW
11:05 am	80	37	37
11:20 am	80	37	37
11:30 am	80	37	38
11:40 am	75	40	41
11:50 am	78	40	43
12:10 pm	75	42	43
12:20 pm	75	42	46
12:40 pm	73	42	46
01:00 pm	68	46	49
01:20 pm	68	49	51
01:40 pm	68	53	52
02:00 pm	68	53	53
02:40 pm	67	55	57
3:00 pm	64	57	59

Source: Data Analysis

IT = Inside Temperature of the System
OTSW = Outside Temperature of the Side Wall
OTBW = Outside Temperature of the Back Wall

From the tables, the outside atmospheric temperature was constant for up to a hour before experiencing infinitesimal change after about a hour plus. The temperatures increase linearly but gently along the slope. The chart below shows inverse proportionality between inside temperature and the outside temperatures. This implies the greater efficiency of the system for smoking of rubber sheet.

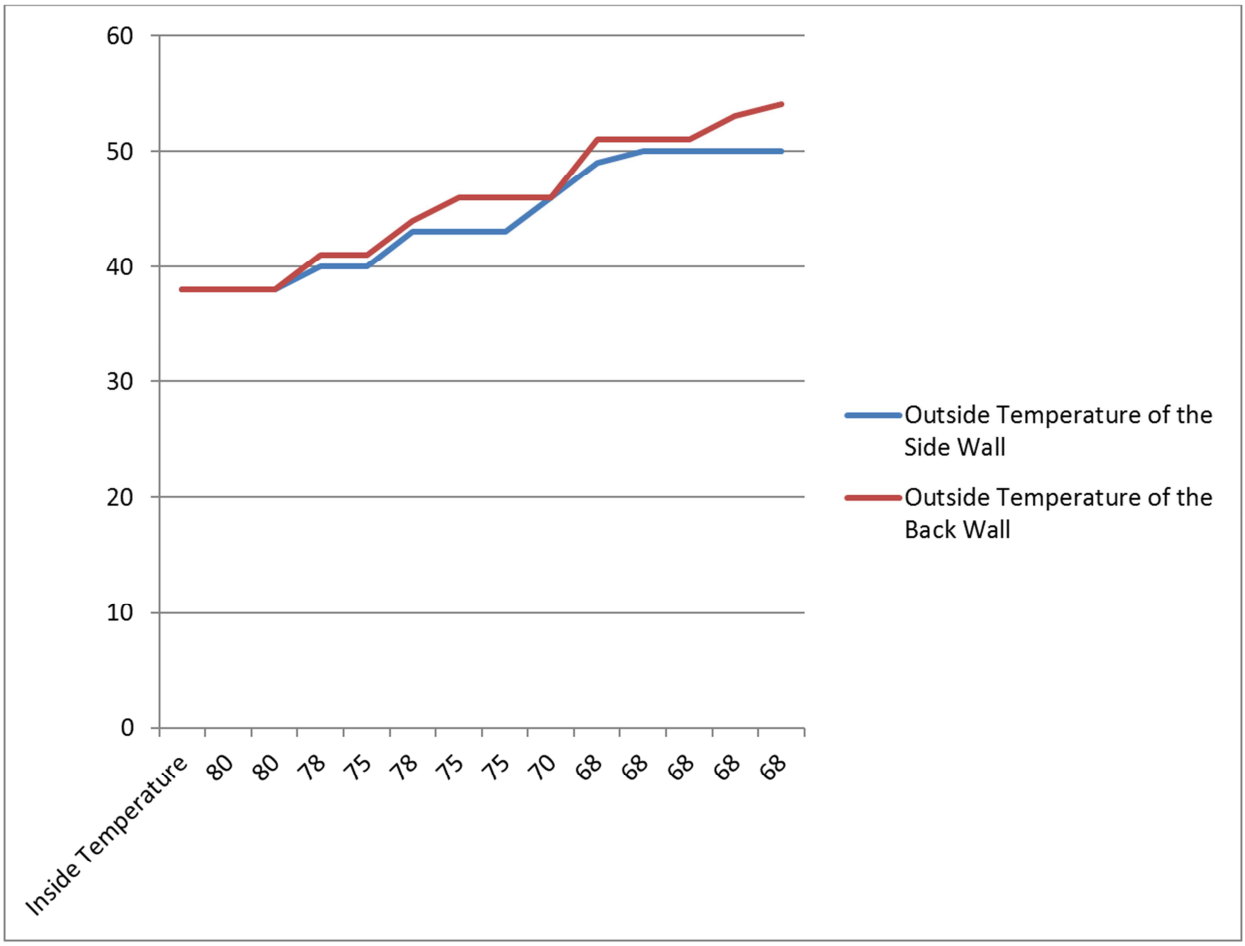

Figure 1. *Chart Showing Outside Temperature Variation for the First Day.*

b. Day 2 –

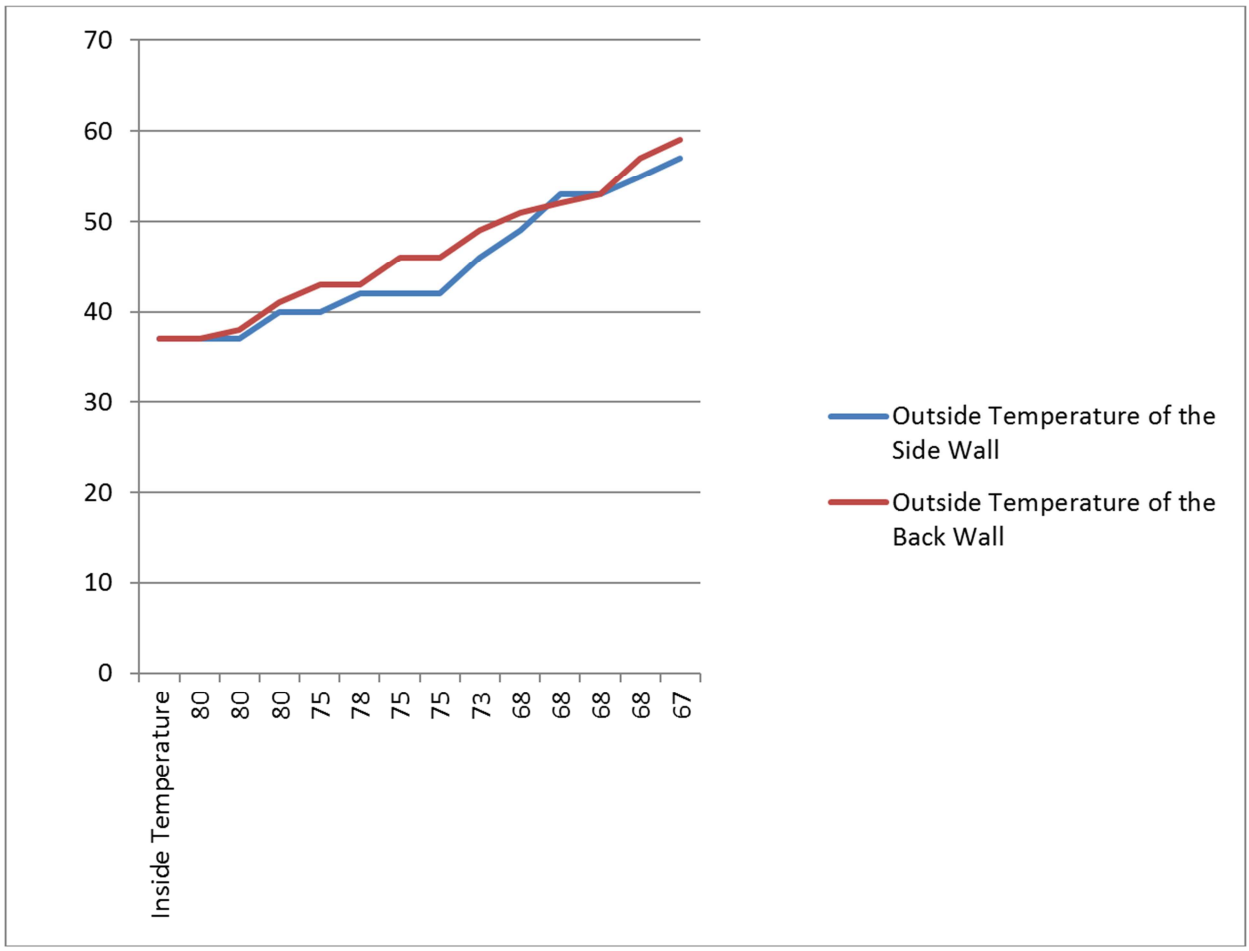

Figure 2. *Chart Showing Outside Temperature Variation for the Second Day.*

Generally from figure 3 and 4, the temperature of back wall is either equal or greater than side wall temperature. The equality in temperature is as result of the unequal surface area while variation is as a result of difference in thickness of the wall.

a b

Figure 3. *a. Constructed Smoking Cabinet Showing Drying Chamber; b. Constructed Smoking Cabinet Showing the External Features.*

a b

Figure 4. *Showing Sheets in the Drying Cabinet and Sheet after Drying Respectively.*

4. Conclusion and Recommendation

The designed system has reduced the drying time of the ribbed smoked sheet from 120 hours of conventional smoke house to 36 hours at 60°C average operating temperature.

The system is economical in term of reduction in fuel consumption and also quality of sheet produced. The technology is hereby recommended for adoption by natural rubber growing farmers to minimize production cost.

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