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DESIGN AND PERFORMANCE TEST OF RUBBER GRINDING MACHINE

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Abstract. *The quality of Rubber processed materials, that is produced by the farmer is generally low and can be seen from their color, pollutants levels, foul odor and the very cheap price. To improve the quality of the rubber should be done both in terms of its treatment and processing equipment. The main objective of this research is to enhance and improve the quality of farmer's rubber processed materials by using natural coagulant which liquid smoke to agglomerate the rubber, and designing of rubber grinding machine. The component of rubber grinding machine including hopper, regulating entry materials, three rollers, pulleys and belt, outlet, gears, engine, regulating the thickness and chassis. In this research, the thickness rubber after grinding is 3-5 mm in accordance with Indonesian National Standard rubber. Processed material rubber produced is white and has no pollutants. The coagulant used was liquid smoke with a concentration of 10 -20%, where this addition affects the agglomeration speed of rubber and smelled slightly of smoke. The average feed rate is 48.58 kg / h, a capacity of the machine is 37.40 kg/h and cost of operation is Rp. 650 / kg.*
Keywords: *rubber processing, grinding machine*

1. Introduction

Natural rubber is a natural resin from plants Havea brasiliensis (Damanik, 2012). Natural rubber is one of the leading export products of Indonesian agroindustry. Indonesia's natural rubber production is 3 million tons/year. This makes Indonesia the second largest rubber producer and exporter in the world (Damayanti, 2013). The use of natural rubber in the industrial world is divided into two, namely the tire and non-tire industries. The use of the tire industry reaches 73% of world natural rubber consumption (Barani, 2012).

Native Americans collect latex and fashion into usable product centuries before Europeans "discover" rubber in 1493 (Stephen L, 2016). Rubber has been used Smallholder rubber plantation produces pre-processed rubber in form of latex, lump, unsmoked sheet, crepe, and slab. Rubber usually processed using traditional means, the processing produced low-quality rubber so that the price is very cheap. The large number of rubber farmers who sell their rubber in the form of lumps in middlemen has resulted in a low income of rubber farmers and the low quality of processed rubber products (Adril, 2013).

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The problem of the low quality of natural rubber materials at present is the unavailability of coagulants that are good to the level of farmers, the number of contaminants is quite large, and how to handle less clean (Handayani, H. 2014). Rubber coagulant process typically uses formic acid which produces foul-smelling and dull color rubber. Pre-processed rubber quality is well reflected by the dry rubber content (KKK) and a level of hygiene.

Rubber processed material quality improvement efforts should start by handling rubber plantations until the final processing stage (Solichin, 2007). Quality control of traded Indonesian Rubber Standard export commodities, the policy must be followed up with quality control so that rubber processed material traded can meet the required quality standards (Telaumbanua et al., 2013). Rubber processed material quality should be in accordance with ISO-Rubber processed material No. 06-2047-2002, where the criteria are no additional non-rubber materials, frozen by using formic acid or others recommended by the proper dose, stored in the shade and not soaked in water. Rubber processed material quality is crucial to the competitiveness of Indonesia's natural rubber in the international market. Generally, raw materials for producing unsmoked sheet rubber is easier to control in terms of quality and continuity of supply of raw materials, because it has been well integrated. The habit of rubber farmers mixing rubber processed material with dirt and other follow-up materials to manipulate rubber processed material weight greatly affects the level of impurities (Asni et al., 2009). However, raw materials originating from the smallholder estate is very diverse. This condition affected rubber quality because of different of material handling.

In the processing of crumb rubber, there are other factors take effect, including the factor of the type of raw materials, coagulant, the process of milling, drying and curing age pre-processed rubber and raw materials. Materials coagulant used in this study is liquid smoke from coconut shell Grade 2 and 3 which contain acid and are antibiotics that can improve the quality of rubber-like eliminating odor, the treatment the rubber is naturally as the liquid that smelled of smoke and shelf life of the rubber longer,

Likewise, the grinding process if uneven, then the cooking process will reduce the quality of pre-processed rubber, as well as the drying process of the impairment ASHT, it is necessary to handling professional manner, given that the tools used in the drying process should be a dryer that works automatically, then the temperature and drying time should be kept constant, so that the expected level of production quality is the standard Indonesian rubber can be fulfilled.

The purpose of the study is to design a simple rubber mill, determine the thickness of the rubber rollers (USS) in accordance with Rubber processed material SNI 06-2047-2002 of a thickness of 3 mm - 5 mm, improving the quality of rubber processed materials produced by the farmers, so prices rubber becomes better and test the quality of pre-processed rubber generated using liquid smoke coagulant.

2. Materials and Methods

The design and development of machine were conducted at Workshop of Politeknik Pertanian Negeri Payakumbuh and performance test at smallholder rubber estate at kecamatan Pangkalan Kabupaten Limapuluh Kota, Indonesia.

Materials and Equipment Used

The materials used for development and test the performance were stainless steel plate, elbow metal, metal plate, coconut shell, liquid smoke, and chemical additives, etc.

Table 1. Equipment used developing the machine

No	Equipm	Volume
1	Motor 7HP	1unit
2	Workshop equipment	1set
3	Laboratory equipment	1set
4	Aluminium coagulant	4unit
5	Laboratory analysis	1set
6	Pyrolysis Tool	1unit
7	Filtration Tool	1unit
8	Rolling cable	1unit
9	Cutter	1 unit

Design

Functional design: rubber grinder was designed to have function as follows

Hopper: material entry

Material entry regulator

Tripple roller: to grind and unify the rubber

Outlet: material exit

Transmission system (gear, pulley and V-belt): to distribute power from motor

Motor: power source of the machine

Framework: to stick all component

Structural design: rubber grinder was designed and has dimension as shown in Figure 1.

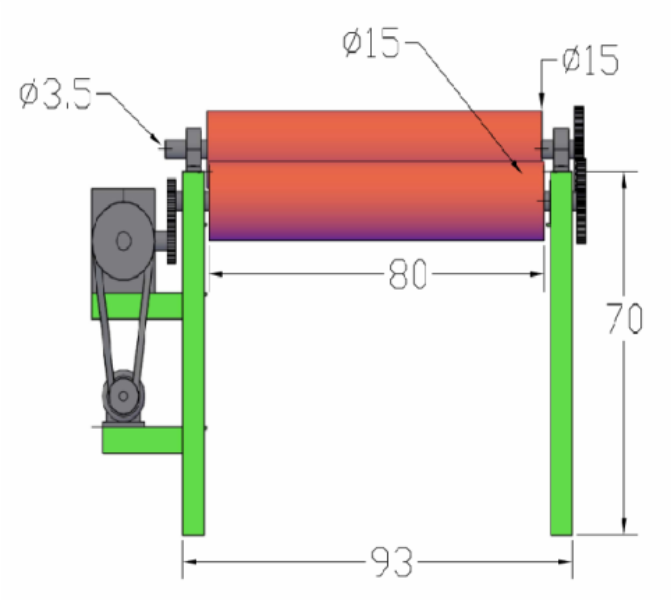

Figure 1. Front view of rubber grinder machine

Latex and Unsmoked Sheet/USS Production Process

Current quality standards of pre-processed rubber inn Indonesia have to met SNI 06-2047-2002, latex manufacture and USS farm must comply with the standard.

Latex process

- Generally latex have the interception of dry rubber content (KKK) between 20-35%, and are less stable and should be processed as quickly as possible. To obtain a good latex gardens, steps must be taken: collect latex gardens were still fresh 3-5 hours after tapping (Pusari dan Haryanti, S, 2014)
- Adding a solution of Liquid Smoke grade 3 (0-20%) of 100-200 ml (1/2 - 1 cup) into the latex gardens in order to avoid the process prakoagulasi
- Coagulum should be separated from latex rubber so as not to clot completely.

Unsmoked sheet/USS

To produce good USS, processing methods are as follows:

- Latex dilution
- Filtering
- Conglomeration
- Flattened
- Blob
- Milling
- Washing
- Aeration / drying
- Quality Requirements (SNI 06-2047-2002)

Determination of dry rubber content USS

Determination of dry rubber content

(K) = W / Wt x 100%

X average = (K1 + K2 + ... + Kn) / n

Applying coagulant substance

Various studies have been conducted to determine the effect of various clumping materials such as using formic acid, organic acid, inorganic acid, alum, and TSP fertilizer to determine its effect on weight loss, dry rubber content and plasticity (Purbaya et al., 2011). Liquid smoke used as rubber coagulant is liquid smoke grade 3 and grade 2. Applying coagulant on USS and *rubber processed material* used with various concentrations of liquid smoke. In the implementation was complete randomized design with three replications ie liquid smoke from coconut shell with concentrations of 5%, 10%, 15% and 20%.

Performance testx

The calculations of the performance of the machine measured were the capacity and the feed rate of the machine.

Economic analysis

In the operation of the rubber mill, calculating cost of operation of the device, Break-even Point (BEP) and B/C Ratio by using economic analysis techniques

3. Result and Discussion

In the implementation of this research has been carried out several activities including the survey to see its location and smallholder rubber processing, manufacturing liquid smoke as rubber coagulant, tool grinder manufacturing rubber and performance test, manufacture of rubber processed materials using for a number of coagulants, grinding rubber grinders, aeration USS and the calculation of economic analysis.

Smallholder Rubber Processing

This study begins by conducting a survey to see the location and conditions of smallholder rubber plantations in Limapuluh kota and surrounding areas, especially Pangkalan and Kapur IX, it aims to directly see how smallholders process the rubber. Processing of latex into pre-processed materials. It is found that the farmers performed by the farmers lacking of cleanliness since a lot of dirt mix with the latex, substance materials was Urea or formic acid, that is stink and the color was dull so that *rubber processed material* has low quality and very low prices that is ranging from Rp. 6000 -

6500 per kg, The price of rubber in Indonesia is the lowest among the other countries, especially Malaysia and Thailand. The productivity of Indonesian rubber land is low and the quality of the rubber produced is also unsatisfactory. In fact, on the international market Indonesian rubber is known as low-quality rubber (Tim Penulis PS, 2008). Pre-processed rubber that produced with improper treatment made it is low appreciated by the industry, but if it had been treated properly, the quality could have improved and would have had higher price.

Design of Rubber Grinder

Design of rubber grinder as shown in Figure 2.

Fig. 2 Rubber grinder machine

Liquid Smoke Production

Liquid smoke is used as rubber coagulant to substitute urea or formic acid that is commonly used among the Indonesian farmer as a rubber coagulant. The liquid smoke was obtained from coconut shell, shell drying process carried out by drying under the sun. This process took time long enough, under normal circumstancein one-week water content of the shell would decrease into 8 -10% (easily broken shells underfoot).

Liquid smoke used was liquid smoke grade 3 which have been allowed to stand for one week and the second-grade liquid smoke that has been distilled once. This liquid smoke is as a preservative, an anti-fungal and anti-bacterial, wherein the liquid smoke

contains long-chain carbon compounds, organic acid compounds, phenol and benzene if unrefined (Novita, 2011). The compounds are expected to eliminate the smell of rubber, rubber agglomerated more durable and better. So in this study the liquid smoke is used in the rubber feeder with varying concentrations i.e. 10%, 15% and 20%.

Pre-Procesed Rubber Manufacturing

The experiment of process of making this *rubber processed material*, starting by purchasing of pure latex with latex pick directly from people's plantation without the use of urea or formic acid. The rubber latex still in liquid form, then latex was filtered and put in a coagulant bath that has been provided, so cleanliness is very good. Latex which has been filtered is mixed with a coagulant such as by using: a) vinegar, b) liquid smoke with a concentration of 10%, c) liquid smoke with a concentration of 15%, d) liquid smoke with a concentration of 20% and e) without coagulant. The effect of adding coagulant to the quality of rubber processed material is seen in Table 2

Table 2. Coagulant addition effect on pre-processed rubber

No	Coagulant	Result			
		Colour	Dirt	Odour	Clotting time
1	Acetic acid (Vinegar)	White	-	rather malodorous	10 hours
2	Liquid smoke 10%	White	-	Odourless, slightly smelled of smoke	20 hours
3	Liquid smoke 15%	White	-	Odourless, slightly smelled of smoke	20 hours
4	Liquid smoke 20%	White	-	Odourless, slightly smelled of smoke	20 hours
5	Whito	White	-	Stink	24 hours

Rubber agglomerate starting from 40 minutes to 24 hours, a new completely merged and rubber can be milled. Latex agglomerating time is depending on the amount of moisture contained in the rubber latex, the higher the amount of water, the longer the coagulation process of latex. From the above data it is known that the addition of acetic acid coagulates faster rubber, while the addition of liquid smoke with various concentrations had no effect on the rate of clotting. Clumping of latex can occur due to damage to the colloidal latex system. The chemicals commonly used in clumping latex are formic acid and acetic acid (Yugia, 2007). Latex by the addition of liquid smoke, has no bad smell (little smell of smoke) while the liquid smoke without coagulant and adding a little vinegar stinks especially stored in a long time. Color rendition for all treatments are the same, namely white, while the impurity content does not exist because the manufacturing processes are clean and controlled

Economic Analysis Tool Grinder Rubber

Economic analysis of rubber grinder machine was to calculate the operational total cost of the machine by using engineering economics. Similar analysis have been used in: Baskara et al., (2018), Azima et al., (2018) and Putera et al., (2019). The results that can be seen in the following Table 3

Table 3. Economic analysis of rubber grinder

Parameter	Value
Asumption approach	
- Selling price (P), Rp/unit	15.000.000
- Machine production cost (S),	1.500.000
- Electricity cost, Rp/KWH	1500
- Economical life time (N),	5
- Interest rate (i), percent	12
- Working hour perday	8
- Working hourper year(X),	2400
- Capacity (C), kg/hour :	37,40
- Materials cost(Rp/kg)	10000
Fixed Cost	
- Depreciation (D), Rp/year	2.700.000
- return of capital (I), Rp/year	900.000
Sum of fixed cost (Rp/year)	3.600.000
Variable Cost	
- fuel consumption , Rp/hour	1500
- Operator salary, Rp/hour	20.000
- Maintenance cost Rp/hour	1620
Sum of variable cost Rp/hour	23.120
Total cost , Rp/kg	650

From the above table it is known that the fixed costs Rp 3.600.00 / year, variable costs Rp 23 120 / hour and the cost of operation of the tool is Rp. 650 / kg. But in general the cost of operation of the device is quite high due to equipment capacity is still small and test the performance of the rubber mill is still in the research level

4. **Conclusions**

From this study it can be concluded:

- The grinding tool can generate wind sit thickness 3-5 mm in accordance with SNI rubber processed material
- Material processed rubber produced is white and no manure levels
- The coagulant used was vinegar, liquid smoke with a concentration of 10 -20% where this addition affects the clotting speed of rubber and smell it caused with little liquid smoke smelled of smoke

- Average feed rate and capacity of the device works is 48.58 kg / h and 37.40 kg / hr
- The cost of operation of the principal is Rp. 650 / kg

On Roller should be given serrations so USS generated to have a better and easier to dry.

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