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Liquid Coal Smoke Processing on Latex Structure and Quality

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Abstract

Rubber productivity in Indonesia has a low value both in terms of quantity and quality when compared to other rubber producing countries such as Malaysia and Thailand. The lack of knowledge of rubber farmers about processing rubber processed materials and the latex freezing process is one of the causes of the low quality of rubber in Indonesia. In this study, grade III and non-grade coal liquid smoke with concentrations of 10%, 25%, 45%, 50%, and 60% was used as a latex coagulant to obtain good agglomeration and rubber quality. The resulting rubber coagulum was ground and air dried. Furthermore, quality measurements were carried out using the SNI-06-1903-2000 method. The results showed that grade III and non-grade coal liquid smoke could thicken latex well starting from grade III and the concentration of non-grade coal liquid smoke was 25%. The higher the concentration of grade III liquid smoke and non-grade coal used, the smaller the dirt content, ash content, volatile matter content, and the color of the rubber coagulum becomes brownish to black after some time. In the study, it was found that 10% and 25% of 10% and 25% non-grade coal liquid smoke could not inhibit bacterial growth due to the low content of acid compounds in liquid smoke, up to 5 days of storage. caterpillars grow in the coagulum. The optimum concentration of liquid coal smoke, both grade III and non-grade in latex coagulation is a concentration of 45%, the required concentration is not too large, but the rubber produced from the coagulation process has good quality and meets SNI standards. The structure of the rubber is influenced by its quality, the lower the quality of the rubber, the more holes the rubber will have because lumps cannot occur perfectly, as a result, the rubber will have holes and break easily when pulled.

Keywords— *Coal, Liquid Smoke, Processed Rubber, Latex, Coagulant*

INTRODUCTION

Jambi Province has economic potential in agriculture, where the agricultural sector contributed 29.83% to GRDP (Gross Regional Domestic Product) in 2014. From the agricultural sector itself, the plantation sub-sector ranks the largest, contributing 16.31%. There are 6 (six) commodities that have been designated as leading commodities in Jambi Province, namely rubber, oil palm, coconut, cinnamon, coffee, and areca nut. In terms of area, rubber commodity ranks at the top, which is 664,739 ha.

In the development of rubber production, many things must be considered, including product quality, economy, energy, safety and environmental friendliness. Indonesia is the owner of the largest land area for rubber plantations in the world. However, when compared to other rubber producing countries such as Malaysia and Thailand, the level of rubber productivity in Indonesia is much lower, both in quantity and quality.

The main cause of the low quality and quantity of rubber processed materials is the lack of knowledge of rubber farmers regarding the handling of latex and rubber processed materials as well as low knowledge of good quality rubber. Farmers tend to do things that can only increase the weight of the rubber processed materials they will sell without considering the quality of the rubber processed materials. The actions taken by farmers include the following:

1. Soaking rubber processed materials in artificial ponds or rivers. In fact, based on the results of the study, bokar immersion can reduce the initial plasticity (Po) and PRI (Plasticity Rubber Index) values at immersion for more than 78 hours, even at immersion for only 12 hours, the PRI value decreased significantly. Soaking rubber processed materials can also cause unpleasant odors.
2. Adding contaminants to rubber processed materials such as chips, soil and other contaminants. Incorporating impurities into rubber processed materials has a wider impact on the latex processing industry. High electrical energy is required when chopping raw materials, as well as a large volume of water required for the washing process.
3. Using coagulants that can absorb water, such as TSP fertilizer and alum. In fact, the actions taken by these farmers tend to produce low-quality rubber processed materials.

The things that the farmers do are not recommended and are very much against government regulations regarding rubber processed materials. According to SNI for Processed Rubber Materials No.66-2047-2002 dated October 17, 2002, high-quality rubber-processed materials must meet several technical requirements, namely as follows:

1. No non-rubber ingredients added
2. Freeze with formic acid / antacid or other recommended ingredients with the right dose
3. Immediately grind in a fresh state
4. Not soaked in water

From the government regulations regarding rubber processed materials above, coagulant is one of the important factors to produce high quality rubber processed materials. Coagulants affect the level of purity and the value of plasticity (Plasticity Rubber Index) of processed rubber materials. The process of clumping or coagulation of latex using a coagulant is by lowering the pH of the latex at its isoelectric point in the range of 4.5-4.7 (Maulina, et al, 2017). To coagulate latex, farmers usually add chemicals in the form of alum, fertilizer, acetic acid or formic acid (antacid) into a bowl of water whose product is known as cup lump. The use of alum and fertilizer is not recommended as a latex coagulant because it can absorb water.

Materials recommended by the government to be used as latex coagulants are acetic acid and formic acid (antacid). The use of acid plays a very important role in avoiding protein degradation during the rubber clumping process and can prevent unpleasant odors from forming in rubber. However, in addition to obtaining good quality, this coagulant can also have a negative impact on the surrounding environment and pose a risk to workers, especially respiratory and skin irritation.

So, taking into account the understanding and skills of latex farmers who are still minimal about the latex coagulation process in the garden, so that it has an impact on the quality of the processed rubber produced, as well as considering latex coagulants which have negative effects on health and the environment, then one solution is to developing rubber production is to use liquid smoke as a latex coagulant. In addition to acetic acid and formic acid (antacid), liquid smoke is one of the recommended coagulants, unfortunately, this coagulant is not widely known by the public. When compared to the use of other recommended coagulants, the use of liquid smoke coagulant is relatively safer because it does not have a negative impact on health and the environment and the price tends to be more affordable.

In this study, liquid smoke obtained from coal pyrolysis (non-grade) and grade III liquid smoke will be used from the research of Saputra et al, 2020. This study intends to determine the role of coal liquid smoke as a latex coagulant as evidenced by physical analysis such as odor, color, and time of coagulation, quality analysis which includes levels of impurities, ash content, and volatile matter content, as well as the structure of the latex produced by coagulation. The

utilization of this liquid smoke is expected to increase the economic value of coal, as well as increase farmers' income due to the increase in the selling price of garden produce. This effort is also an energy and water efficiency measure in latex processing plants that can reduce production costs, and also as an effort to reduce the level of odor pollution and health risks for communities around plantations and factories.

RESEARCH METHODS

This study used a qualitative approach and was carried out in the Chemical Engineering laboratory, Jambi University. The tools used in this study consisted of a stirring rod, erlenmeyer, hot plate, beaker glass, pH meter, funnel, measuring cup, stopwatch, oven, furnace, porcelain cup, spatula, container and lid, bottle, analytical balance and test sieve 325. mesh. While the research materials consist of latex, liquid smoke of coal grade III and non-grade, cureo TS, mineral turpentine and aquadest.

Work procedures

Latex Preparation Stage

The latex used in this study came from a community rubber plantation in Paal 11, Muaro Jambi Regency, Jambi Province. The tapped latex is then accommodated and brought to the research laboratory. Before coagulation is carried out, the latex is filtered first to remove impurity particles so as not to affect the quality of the latex.

1.Liquid Smoke Dilution Stage

In this study, grade III and non-grade coal liquid smoke from the research of Saputra et al, 2020 will be made with various concentrations as a latex coagulant. The concentrations used are 10%, 25%, 45%, 50% and 60%. Dilution of grade III and non-grade coal liquid smoke is carried out using a diluent in the form of water based on the dilution formula.

2.Latex Coagulation Stage

The latex coagulation process is carried out by adding liquid smoke of grade III and non-grade coal at various concentrations by using a ratio between liquid smoke of coal and latex to be coagulated, which is 4: 9. Where liquid smoke is used as much as 60 ml and latex as much as 135 ml. . Mixing liquid smoke into latex accompanied by stirring evenly. Once evenly distributed, allow the latex to solidify and record the length of coagulation time. Observations were also made on pure latex that did not experience the addition of liquid smoke which would later be used as a physical and quality comparison.

3. Latex Characterization

After the latex was coagulated, it was characterized using a Scanning Electron Microscope (SEM) and color analysis on the rubber. In addition, quality analysis was also carried out which included analysis of volatile substances content, ash content and dirt content based on SNI 06 – 1903 – 2000. Analysis of volatile substances content was calculated using equation 1 below:

$$\text{Evaporation rate} = \frac{A-B}{C} x\ 100\% \qquad (1)$$

Where A is the weight of the cup and the sample before heating, B is the weight of the cup and the sample after being heated and C is the weight of the test piece. Then for the analysis of ash content is calculated using equation 2:

$$\text{The ash content} = \frac{A-B}{C} x\ 100\% \qquad (2)$$

Where A is the weight of the porcelain cup with ash (grams), B is the weight of the empty porcelain cup (grams) and C is the weight of the sample (grams). Furthermore, the dirt content analysis is calculated by equation 3:

$$\text{Dirt level} = \frac{A-B}{C} x\ 100\% \qquad (3)$$

Where A is the weight of the test sieve and dirt, B is the weight of the empty test sieve and C is the weight of the sample.

RESULTS AND DISCUSSION

Coagulation time

Coagulation time analysis is used to see how fast the liquid smoke can coagulate or freeze the latex. From the research that has been done, the results obtained from the effect of the concentration of liquid smoke on the coagulation time as can be seen in Figure 1.

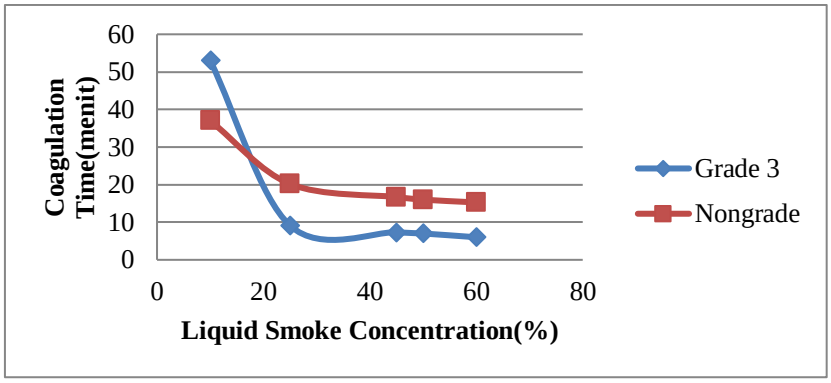

Figure 1. Effect of Liquid Smoke Concentration on Coagulation Time

From Figure 1. it can be seen that the higher the concentration of liquid smoke, the faster the coagulation time. This applies to both grade III liquid smoke and non-grade liquid smoke. The higher the concentration of liquid smoke, the higher the pH of the liquid smoke, because it contains more acidic compounds.

From the observations that have been made, it is known that for grade III liquid smoke with concentrations of 60%, 50%, 45%, 25%, and 10% added to latex, the required coagulation time is 6 minutes, 7 minutes, 7 minutes, respectively. minutes 32 seconds, 9 minutes 12 seconds, and 53 minutes. While the observations for non-grade liquid smoke with concentrations of 60%, 50%, 45%, 25%, and 10% added to latex, the required coagulation time is 15 minutes 27 seconds, 16 minutes, 16 minutes 70 seconds, 20 minutes 19 seconds, and 37 minutes.

From the observations that have been made, it is known that the coagulation time using grade III liquid smoke tends to be faster than the coagulation time using non-grade liquid smoke. This is because the pH of grade III liquid smoke is more acidic than the pH of non-grade liquid smoke. Where the pH of grade III liquid smoke is 3.0 while the pH of non-grade liquid smoke is 3.7. The higher the pH of the liquid smoke, the faster the latex pH will decrease until it reaches its isoelectric point, so that the coagulation process occurs faster. For pure latex without the addition of liquid smoke, it takes 2 hours 52 minutes to freeze. With the addition of liquid smoke is expected to help rubber farmers to shorten the latex coagulation process.

Color on rubber

When grade III liquid smoke is added, the latex has a white to yellowish-white color, while the latex added to non-grade liquid smoke has a yellowish white to light brown color during the coagulation process. The color of the latex is influenced by the concentration of liquid smoke, the higher the concentration, the more concentrated the color of the latex will be. As can be seen in Figure 2. And Figure 3.

Figure 2. Latex with grade III . liquid smoke coagulant

Figure 3. Latex with non-grade liquid smoke coagulant

The condition of the coagulum at the beginning of clotting is very soft, smells of smoke and is white, yellowish white to brownish white. Over time, after a few days the coagulum became denser because some of the water trapped in the coagulum had come out, the color changed to brownish black. According to Ompusunggu (1995), the role of pH is to determine the quality of rubber. Clumping at a very low pH resulted in a darker rubber color and a lower rubber modulus. on the other hand, the advantage is that the clotting time is fast and the PRI value can be maintained as high as possible. The latex that has been coagulated using liquid smoke can be seen in Figure 4.

The brownish black color of rubber does not only occur in latex coagulated using liquid smoke, but also occurs in latex coagulated using formic acid with a pH of 3.77. Formic acid is one of the latex coagulants whose use is recommended by the government. The use of formic acid as a latex coagulant changes the latex coagulum to a brownish black color. This is in accordance with the statement of Ompusunggu (1995) which states that the pH of the coagulant affects the color of the coagulated rubber, where the lower the pH, the darker the color of the rubber. The latex coagulated using formic acid can be seen in Figure 5.

The latex was coagulated using grade III liquid smoke with a concentration of 10%, the latex was coagulated using 10% and 25% non-grade liquid smoke, and pure latex without coagulant, after 5 days of storage maggots appeared on the rubber surface. This is due to the absence or low content of phenols and acidic compounds in liquid smoke with low concentrations. As a result, bacteria can multiply and cause maggots to grow. It is known that phenol and acetic acid are compounds that have antibacterial properties. The higher the concentration of phenol and acetic acid, the better the ability as an antibacterial. Maggots growing on latex produced by coagulation of grade III liquid smoke with a concentration of 10%, non-grade concentrations of 10% and 25%, and pure latex without coagulant can be seen in Figure 6.

Figure 4. Rubber After Coagulation Using Liquid Smoke

Figure 5. Latex Coagulated Using Formic Acid (Asmawit, et al, 2011)

Figure 6. a) Maggots Growing on Latex Liquid Smoke Coagulation Grade III Concentration of 10% , b) non-grade Concentration of 10% c) non-grade Concentration of 25% and d) Pure Latex Without Coagulants

Quality on rubber

Dirt level

The research data for the test of impurities in latex that has been coagulated using grade III and non-grade liquid smoke with concentrations of 10%, 25%, 40%, 50%, and 60% can be seen in Figure 7 below:

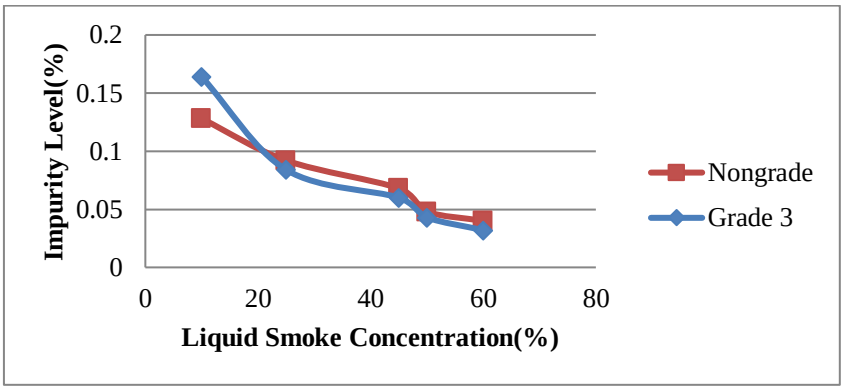

Figure 7. Effect of Liquid Smoke Concentration on Impurity Levels

From Figure 7 it can be seen that the higher the concentration of liquid smoke, both grade III and non-grade liquid smoke, the lower the levels of impurities contained in the rubber. Where for latex which is coagulated using grade III liquid smoke with concentrations of 10%, 25%, 45%, 50%, and 60% has impurities levels in a row: 0.164%; 0.084%; 0.060%;0.043%; and 0.032%. Then, the latex which was coagulated using non-grade liquid smoke with concentrations of 10%, 25%, 45%, 50%, and 60% had impurities, respectively: 0.128%; 0.092%; 0.068%; 0.048%; and 0.040%. While pure latex without coagulant has a fairly high level of impurities, namely 0.22%

Analysis of dirt content is an analysis used to determine the level of dirt in the form of foreign objects contained in the rubber. The level of impurities contained in the rubber can indicate the good or bad quality of the rubber itself. The higher the value of the dirt content, the worse the quality of the rubber. On the other hand, the lower the level of impurities, the better the quality of the rubber. According to SNI 06-1903-2000 concerning Standard Indonesian Rubber (SIR), the level of impurities should not be more than 0.20%. From the tests that have been carried out, it can be concluded that the levels of impurities in pure latex without coagulant do not meet the standards. While the level of impurities in the latex that has been coagulated using liquid smoke meets the standard, the value is below 0.20%.

Ash Level

Ash content is a minimum description of the number of minerals present in rubber. The research data for the ash content test on latex that has been coagulated using grade III and non-grade liquid smoke with concentrations of 10%, 25%, 40%, 50%, and 60% can be seen in Figure 8. below:

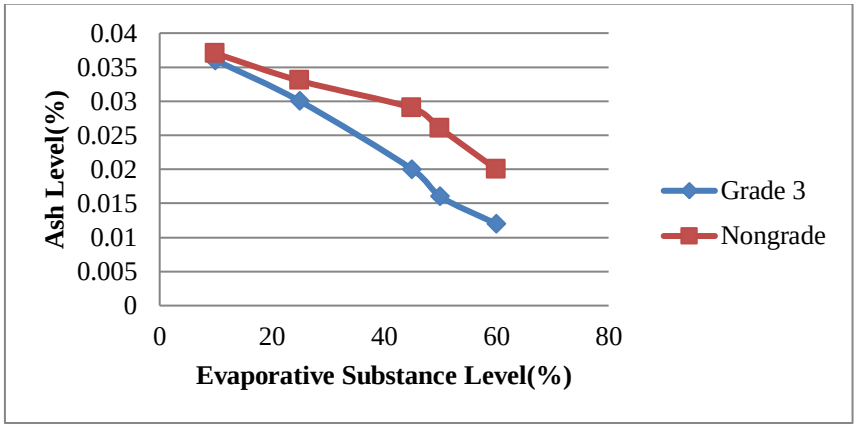

Figure 8. Effect of Liquid Smoke Concentration on Ash Levels

From Figure 8. it can be seen that the higher the concentration of liquid smoke, both grade III and non-grade liquid smoke, the lower the ash content contained in the rubber. Where for latex which is coagulated using grade III liquid smoke with concentrations of 10%, 25%, 45%, 50%, and 60%, the ash content is 0.036%, respectively; 0.030%; 0.020%; 0.016%; and 0.012%. Then, the latex coagulated using non-grade liquid smoke with concentrations of 10%, 25%, 45%, 50%, and 60% had ash content, respectively: 0.037%; 0.033%; 0.029%; 0.026%; and 0.020%. While pure latex without coagulant has an ash content of 0.058%.

Ash content is a minimum description of the number of minerals present in rubber. Rubber ash content varies in the form of carbonates and phosphates of potassium, magnesium, calcium, sodium, and several other elements in different amounts. Some mineral materials in rubber leave ash which can reduce the flexural resistance of rubber from vulcanization of natural rubber (Safitri, 2010). So it can be said that the higher the ash content in the rubber, the worse the quality of the rubber, conversely, the lower the ash content in the rubber, the better the quality of the rubber. Where according to SNI 06-1903-2000 concerning Standard Indonesian Rubber (SIR), the ash content should not be more than 1%.

From the tests that have been carried out, it can be concluded that the ash content of latex that has been coagulated using liquid smoke and latex without coagulant has met the standard because the value is far below 1%. However, the quality of latex coagulated using liquid smoke is better than latex without coagulant because the value of the ash content is smaller.

Evaporative Substance Level

The research data for the test of volatile substances in latex that has been coagulated using grade III and non-grade liquid smoke with concentrations of 10%, 25%, 40%, 50%, and 60% can be seen in Figure 9. below:

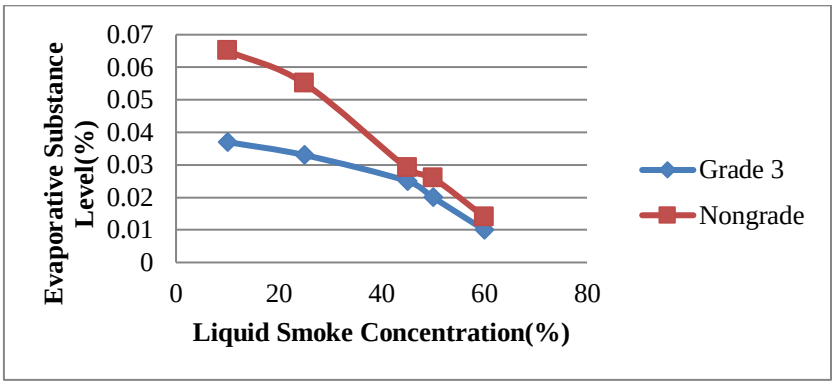

Figure 9. Effect of Liquid Smoke Concentration on Evaporative Substance Levels

From Figure 9. it can be seen that the higher the concentration of liquid smoke, both grade III and non-grade liquid smoke, the lower the volatile matter contained in the rubber. Where for latex which is coagulated using liquid smoke grade III with concentrations of 10%, 25%, 45%, 50%, and 60% has volatile substances, respectively: 0.037%; 0.033%; 0.025%; 0.020%; and 0.010%. Then, the latex coagulated using non-grade liquid smoke with concentrations of 10%, 25%, 45%, 50%, and 60% had volatile substances, respectively: 0.065%; 0.055%; 0.029%; 0.026%; and 0.014%. While pure latex without coagulant has a volatile substance content of 0.10%.

The volatile substance in rust consists mostly of water vapor and the rest is other substances such as serum which is volatile at 100°C. The presence of volatile substances in rubber, besides being able to cause a foul odor, can also facilitate the growth of fungi which can cause difficulties when mixing chemicals into rubber during the rubber production process in industry. So it can be said that the higher the volatile matter content in the rubber, the worse the quality of the rubber, conversely, the lower the ash content in the rubber, the better the quality of the rubber. Where according to SNI 06-1903-2000 concerning Standard Indonesian Rubber (SIR), the volatile substance in rubber should not be more than 0.80%.

From the tests that have been carried out, it can be concluded that the level of volatile substances in latex that has been coagulated using liquid smoke and latex without coagulant has met the standard because the value is far below 0.80%. However, the quality of latex coagulated using liquid smoke is better than latex without coagulant because the value of the vapor content is smaller.

Surface morphology on rubber

Based on the quality tests that have been carried out, the results show that the latex coagulated using liquid smoke is of better quality than the latex coagulated without coagulant. From these different qualities, we want to know the surface structure of each rubber by testing using a Scanning Electron Microscope (SEM).

For the SEM test, latex that has been coagulated using grade III liquid smoke and non-grade liquid smoke with a concentration of 45% was selected, because from the quality tests that have been carried out in this study liquid smoke with a concentration of 45% is the most optimal as a latex coagulant. The following are the results of the SEM test with 500x image

magnification for latex with 45% concentration of grade III liquid smoke coagulant, latex with 45% concentration of non-grade liquid smoke coagulant, and pure latex without coagulant:

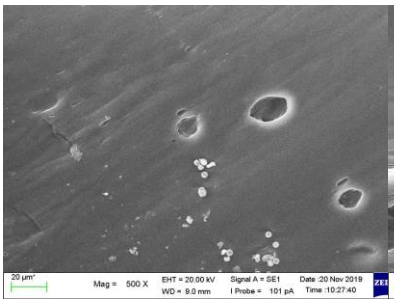

Figure 10. SEM images of latex with water smoke coagulant grade III 45% concentration

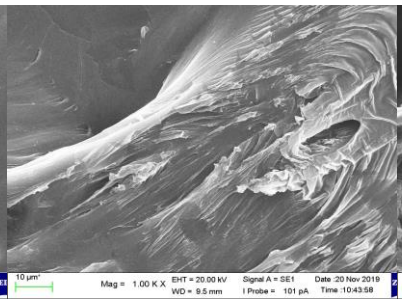

Figure 11. SEM images of latex with non-grade water smoke coagulant with a concentration of 45%

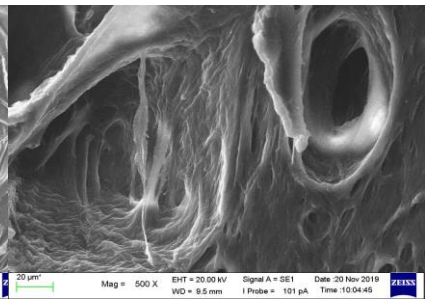

Figure 12. SEM image of pure latex without coagulant

In the SEM test that has been carried out, from the three latex coagulums that were coagulated using grade III liquid smoke with a concentration of 45%, non-grade liquid smoke with a concentration of 45%, and pure latex without coagulant, it can be seen that the latex coagulated using grade III liquid smoke with a concentration of 45% has the best quality. This is evidenced by the absence of cavities in the rubber. Liquid smoke has a good role in the coagulation process, where with the addition of 45% concentration of grade III liquid smoke, rubber has the lowest value of impurities, ash content and volatile substances compared to latex + nongrade liquid smoke 45% and pure latex without coagulant. Where the levels of impurities, ash content and volatile matter content in latex coagulated using liquid smoke grade III 45% were 0.060%, 0.020%, and 0.025%, respectively. The impurities, ash content and volatile matter content of latex coagulated using non-grade III 45% liquid smoke were 0.068%, 0.029%, and 0.029%, respectively. Meanwhile, the impurities, ash content and volatile matter content of pure latex without coagulant were 0.22%, 0.058%, and 0.10%, respectively.

The low levels of dirt, ash content, and volatile matter content in rubber, cause latex clumping to occur completely, so that the latex structure becomes tight because there are no other impurities in the rubber except the rubber itself. On the other hand, if the content of dirt, ash content, and volatile matter content is high, it will cause latex clumping to occur imperfectly, so that the rubber will have many cavities due to the large number of these impurities. The cavities in the rubber cause the rubber to break more easily when pulled.

CONCLUSION

From the research that has been done, it can be concluded as follows:
1. In the latex coagulation process using grade III coal liquid smoke with concentrations of 10%, 25%, 40%, 50%, and 60%, the coagulation time required until the latex completely clots is less than 1 hour. The color of the coagulum is initially white to yellowish white, after a few days the coagulum changes color to brownish black. In the quality test for latex coagulated using liquid smoke with concentrations of 10%, 25%, 40%, 50%, and 60%, the impurities content value is less than 0.20%, the ash content value is less than 1%, and the substance content value is less than 0.20%. evaporate less than 0.80%
2. In the latex coagulation process using non-grade coal liquid smoke with concentrations of 10%, 25%, 40%, 50%, and 60%, the coagulation time required until the latex completely clots is less than 1 hour. The color of the coagulum is initially white to yellowish white, after a few

days the coagulum changes color to brownish black. In the quality test for latex coagulated using liquid smoke with concentrations of 10%, 25%, 40%, 50%, and 60%, the impurities content value is less than 0.20%, the ash content value is less than 1%, and the substance content value is less than 0.20%. evaporates less than 0.80%.

3. Optimal concentration of liquid smoke as a latex coagulant, both for grade III liquid smoke and non-grade liquid smoke, namely liquid smoke with a concentration of 45%. Because the concentration required is not too large, the rubber produced from the coagulation process has good quality and meets SNI standards. The coagulated rubber using 45% grade III liquid smoke has a smooth structure and is not hollow, while the coagulated rubber using 45% non-grade liquid smoke has a non-smooth and hollow structure.

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