

# Slab Quality and Environmental Degradation with The Addition of Additives and Coagulant

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## Article history

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**Abstract:** This research used ammonium chloride at doses of 0%, 0.15%, 0.30% and 0.45% with 0% dose, 0.15%, 0.30% and 0.45% while formic acid and liquid smoke coagulants. The objective of this research is to determine the effects of the addition of additives (NH<sub>4</sub>Cl) and the type of coagulants on the quality slab degradation. The observed parameters were the value of dry rubber content (%), initial plasticity (Po), plasticity retention index (PRI), ash content (%), volatile matter (%) and Mooney viscosity. The results showed that doses ammonium chloride and coagulants affected to the value of dry rubber content (%), initial plasticity (Po), plasticity retention index (PRI), ash content (%), volatile matter (%) and Mooney viscosity. The treatment dose 0.45% ammonium chloride with coagulant has the best combination treatment reason it produced slab with dry rubber content 46.517%, initial plasticity 45, plasticity retention index 94, ash content 0.278%, volatile matter 0.604% and Mooney viscosity 72.

**Keywords:** Ammonium chloride, coagulants and slab.

**Abstrak (Indonesian):** Penelitian ini menggunakan amonium klorida dengan dosis 0%, 0,15%, 0,30% dan 0,45% sedangkan jenis koagulan asam format dan asap cair. Penelitian ini dilakukan untuk mengetahui pengaruh penambahan zat aditif (NH<sub>4</sub>Cl) dan jenis koagulan terhadap degradasi mutu sleb. Parameter yang diamati adalah kadar karet kering (%), plastisitas awal (Po), indeks retensi plastisitas (PRI), kadar abu (%), kadar zat menguap (%), viskositas Mooney. Hasil penelitian menunjukkan bahwa penambahan dosis amonium klorida dan jenis koagulan berpengaruh nyata terhadap kadar karet kering (%), plastisitas awal (Po), indeks retensi plastisitas (PRI), kadar abu (%), kadar zat menguap (%), viskositas Mooney. Perlakuan dosis amonium klorida 0,45% dengan koagulan asam format merupakan perlakuan terbaik menghasilkan kadar karet kering 46,517%, plastisitas awal 45, indeks retensi plastisitas 94, kadar abu 0,278% , kadar zat menguap 0,604% dan viskositas Mooney 72.

**Kata kunci:** Amonium klorida, koagulan dan sleb.

## 1. Introduction

Slab quality in Indonesia still has poor quality that can be seen from many dirty slab, the thickness which does not fulfill the criteria of clean *bokar* and soaked in water before being sold in order to add weight of slab. The good material quality is reflected by dry rubber content (KKK) and high level of hygiene [1]. Improving the quality of slab can be done by adding a chemical substance as an additive. Rubber added chemicals will have a viscosity that fixed and does not change for some time.

Ammonium chloride (NH<sub>4</sub>Cl) can be used as additives in improving the quality of latex. The used of

ammonium chloride 0.15% (w / w) of dry rubber produced initial plasticity (Po) of 32 with at least 30 Po SIR 20, decreasing the Mooney viscosity became constant 69 and lower ash content became 0.48% grading SIR 20 ash at maximum 1% [2]. In order to get the slab quality produced fulfilled Standard Indonesian Rubber, research must be done using ammonium chloride at doses of 0%, 0.15%, 0.30% and 0.45% (w/w) of dry rubber to get a dose of ammonium chloride in optimal used of coagulants that recommended is formic acid and liquid smoke.

Formic acid coagulant can produce rubber with good technical specifications and fulfill the Indonesian

National Standard of 06-2047-2002 [3]. Formic acid contains of acidic with a pH ranging from 1 to 2 that serves to freeze the latex.[4]. the used dose of formic acid as a coagulant is 2% as recommended by Sembawa Research Institute. The overload used of formic acid can increase weight loss (losses), longer drying time and more amount of grinding. Excess acid will also cause the lower value of plasticity, whereas the higher ash content and evaporates levels of substance.

Liquid smoke as a coagulant has been recommended by Sembawa Research Institute. The used dose recommended of liquid smoke is 5% per liter of latex [5]. Liquid smoke can preserve the value of Po and PRI, preventing and closing a foul odor in latex clot and affect the speed of the coagulation process, color, aroma and rich core within *bokar* [6].

## 2. Experimental Sections

This research was conducted at Laboratory Technology, Sembawa Rubber Research Institute, Banyuasin, South Sumatra from August 2016 until November 2016. The research design used in the research was factorial completely randomized design with two treatment factors (A and B) which consisted of four treatments for doses of ammonium chloride and two treatments for types of coagulant. Factors A :  $A_1= 0\%$ ,  $A_2= 0,15\%$ ,  $A_3 = 0,30\%$  and  $A_4= 0,45\%$  (w/w) dry rubber. Factors B :  $B_1 =$  Formic acid 2% dan  $B_2 =$  liquid smoke 5%.

## 3. Results and Discussion

### 3.1. Rubber Dry Content

Dry rubber content was lowest for the  $A_1B_2$  while the dry rubber content was highest at treatment  $A_4B_1$ . The average value of dry rubber content can be seen in Figure 3.1.

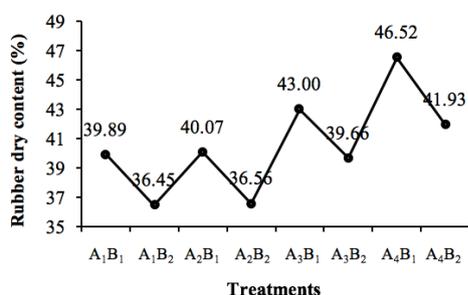


Figure 3.1. Mean dry rubber content (%)

Based on analysis of uniformity showed that the addition of ammonium chloride and type of coagulant significant effect on dry rubber content but the interaction of ammonium chloride and type of coagulant effect was not real.

This shows that increasing doses of ammonium chloride can increase dry rubber content. This is due to the addition of ammonium chloride can increase the

molecular weight of the rubber. The molecular weight of ammonium chloride is 53.491 g/mol. Sleb good Karakteristis one of which has a daily dry rubber content of 39.01% [7]. Thus the addition of ammonium chloride 0.45% (weight per weight of dry rubber) able to increase daily dry rubber content (0 days).

Dry rubber content using a coagulant liquid smoke ( $B_2$ ) is lower than using formic acid coagulant ( $B_1$ ). This is because the coagulant formic acid can lower the pH reached the isoelectric sleb (pH 4.7), which causes the rubber particles lose charge or be neutral and clotting increasingly fast. According to the research data obtained, the pH of use of formic acid in the amount of 4.7 while using liquid smoke of 5.1. Time clots affect dry rubber content, the faster clotting times the dry rubber content higher [17].

### 3.2. Initial Plasticity

Initial plasticity value obtained from studies ranging from 33 to 45. initial plasticity lowest for the treatment without the use of ammonium chloride coagulant liquid smoke ( $A_1B_2$ ) that was equal to 33 and plasticity was highest early in treatment using 0.45% ammonium chloride coagulant formic acid ( $A_4B_1$ ) that was equal to 45. Value plasticity generally preferred initial consumer (tire manufacturer) of more than 30. the mean initial plasticity can be seen in Figure 3.2.

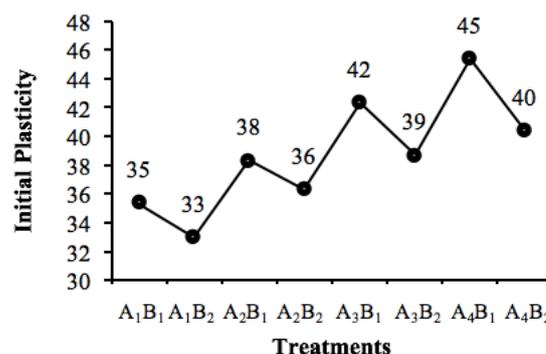


Figure 3.2. Mean initial plasticity

Results of analysis of variance showed that the addition of ammonium chloride and type of coagulant significant effect on the plasticity of the beginning but the interaction of ammonium chloride and type of coagulant effect was not real.

The results showed that the greater the dose the addition of ammonium chloride then the higher initial plasticity. Adding ammonium chloride will extend mikrogel, the individual bonds in the rubber particles (intra-particle crosslink) and will occur more crosslinking called makrogel. That crosslinks will cause initial plasticity ( $P_o$ ) high [5].

The was because the formic acid was a coagulant suggestion that produces high-quality rubber. One of the efforts to improve the quality of rubber that was used

coagulant formic acid [5]. Coagulant to produce formic acid initial plasticity in accordance with the conditions set by SNI 06-1903-2000, at least 30.

### 3.3. Plasticity Retention Index (PRI)

Based on the research got plasticity retention index values ranging from 77 to 94. The average value of plasticity retention index can be seen in Figure 3.3.

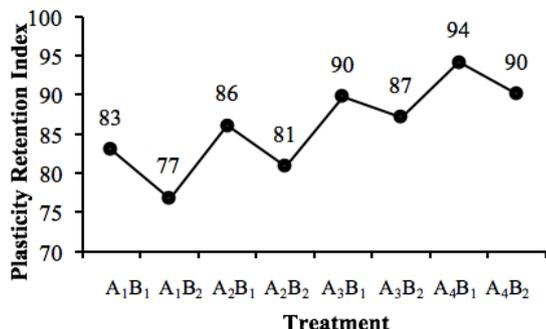


Figure 3.3. Mean Plasticity Retention Index

The results showed that the larger the addition of ammonium chloride then plasticity retention index value will be even greater. Thwas was because the ammonium chloride was able to maintain the rubber against degradation by high temperatures. The value of high plasticity retention index indicates that the natural rubber reswastant to high temperatures. The content of constituent particles of rubber were natural antioxidants that can prevent disconnection rubber molecular chains caused by the oxidation process [7].

Plasticity retention index using a coagulant liquid smoke (B<sub>2</sub>) was lower than using formic acid coagulant (B<sub>1</sub>). the more antioxidants in the rubber, the rubber molecule chains will be reswastant to oxidation. Antioxidants were protective rubber molecules by oxidation at high temperatures so that the value of the initial plasticity and high plasticity retention index[8]. The higher the acidity level of the coagulant, then the value of plasticity index higher. [9].

### 3.4. Ash Content (%)

Average ash content ranging from 0.278% to 0.681%. The average value of ash content can be seen in Figure 3.4. Based on analysis was of uniformity showed that the addition of ammonium chloride and type of coagulant had significant affected on ash content. The interaction of ammonium chloride and type of coagulant effect had significant.

The results showed that the larger the addition of ammonium chloride can decrease the value of ash content. That was due to the addition of ammonium chloride to latex can clean the metal so that the amount of metal contained therein will decrease. In accordance with the statement of Kirk and Othmer (1998) and Wulan

Wahyu (2010), one of which uses ammonium chloride as metal cleaning [10].

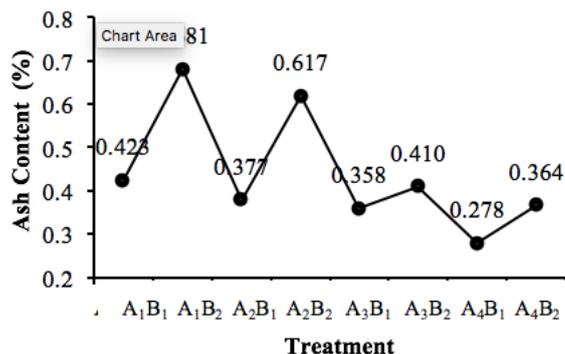


Figure 3.4. Mean ash content (%)

Quality requirements for ash content in Standard Indonesian Rubber 20 SNI 06-1903-2000 was maximum of 1.00% so the addition of ammonium chloride was able to improve the quality of the ash content. Low ash content of rubber was expected due to the nature of copper metal (Cu) and manganese (Mn) was a pro-oxidation was the oxidation reaction catalyst in the rubber, in concentrations over the limit will damage the quality of rubber [11].

The ash content using formic acid coagulant (B<sub>1</sub>) was lower than using coagulant liquid smoke (B<sub>2</sub>). That was because it contained liquid smoke contains compounds that can serve as an antibacterial, antioxidant, freezer, and a distinctive smell of smoke. Which serves as an antibacterial compound was phenol and its derivatives, which will kill the bacteria in latex and clot so that no stench. [13].

### 3.5. Volatile Matter (%)

Volatile matter obtained from studies ranging from 0.239% to 0.690%. The average value of substance evaporates levels can be seen in Figure 3.5.

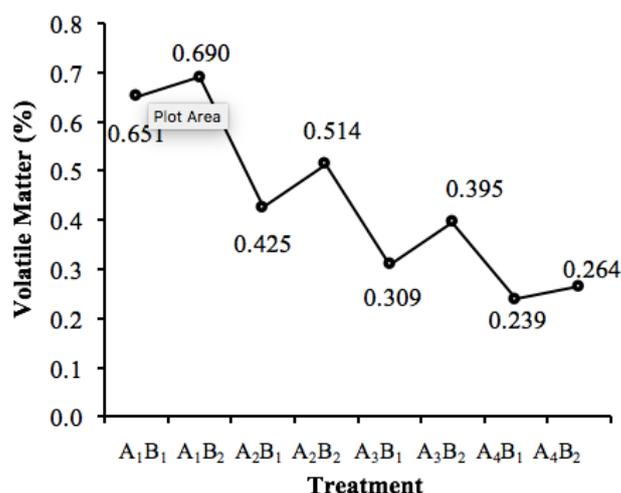


Figure 3.5. Volatile matter (%)

High volatile matter showed high water content contained in the rubber, so that the rubber will become mushy. Volatile matter that exceed the SIR (maximum 0.80%), the rubber cannot be accepted and marketed [8]. The higher the value substance evaporates, the lower the quality of rubber[13].

Volatile matter using formic acid coagulant (B<sub>1</sub>) was low instead of using the coagulant liquid smoke (B<sub>2</sub>). That showed that the use of formic acid coagulant to produce a dry slab perfectly and in accordance with the requirements of SNI 06-1903-2000 was a maximum of 0.8%.

Levels of substance evaporates shows the drying rate and to ensure perfect drying. Based on previous research conducted by Arzuki et al., (2015), the use of formic acid coagulant can produce lower levels of substance evaporates as compared to other types of coagulants such as liquid smoke, sulfuric acid and alum.[11].

### 3.6. Mooney Viscosity

The Mooney viscosity was lowest for the treatment A<sub>1</sub>B<sub>1</sub> and a Mooney viscosity highest in treatment A<sub>4</sub>B<sub>2</sub>. The average value Mooney viscosity can be seen in Figure 3.6.

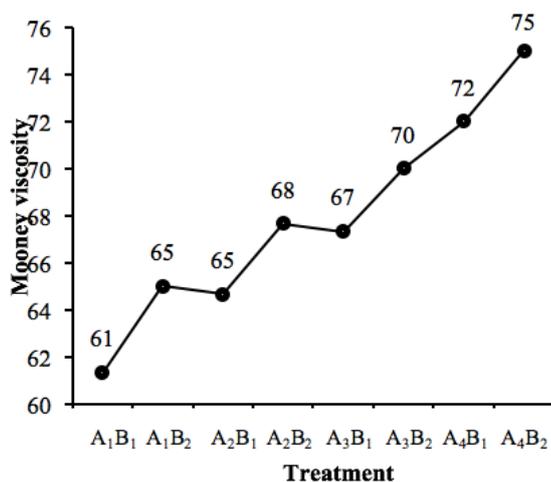


Figure 4.6. Mooney viscosity

The addition of ammonium chloride can increase Mooney viscosity. That was because instead of rubber compounds to form cross links dissolved in the serum phase, so that the resulting hard rubber. Adding ammonium chloride in the manufacture of slab also extended the molecular chain of rubber. the higher the value the more longer the Mooney viscosity natural rubber molecule chains [7].

The degree of cross linking high molecular chains expressed more crosslinking reaction (cross linking reaction) that occurs, thereby increasing the value of Mooney viscosity natural rubber [14].

Coagulant formic acid was produced a lower Mooney viscosity compared with liquid smoke. That was because the liquid smoke had a molecular weight greater than with formic acid which illustrates that the bonds between the molecules making up the coagulated rubber monomer more. High Mooney viscosity can also be caused by the occurrence of crosslink on natural rubber [15]. Consumer request was to vary Mooney viscosity, for example Goodyear between 65-75, 80-85 Michelin, 75-85 Yokohama, and 62-72 Aliance, it indicates that consumers want constant Mooney viscosity. In accordance with African Standard Rubber grade 3 (SAR-3) in Onyeagoro (2012), Mooney viscosity natural rubber was 70 [16].

### 4. Conclusion

1. The addition of ammonium chloride and coagulants treatment significantly affected the dry rubber content, initial plasticity, plasticity retention index, ash content, volatile matter and Mooney viscosity.
2. The interaction between factor A (dose ammonium chloride (NH<sub>4</sub>Cl) and factor B (type coagulant) significantly affected the ash content.
3. The best treatment there in treatment A<sub>4</sub>B<sub>1</sub> (ammonium chloride coagulant 0.45% with formic acid), because it produced a dry rubber content (KKK) of 46.517%, the initial plasticity at 45, plasticity retention index was 94, amounting to 0.278% ash content, volatile matter at 0.239% and a Mooney viscosity of 72.

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