Use of liquid natural latex for the manufacture of waterproof canvas fabric

Luftinor, Nasruddin, S. Agustini and AT. Bondan
Palembang Industrial Research and Standardization Center, Jl. Perindustrian II No. 12 Km 9
Sukarami Palembang 30152 Indonesia

Corresponding author email: luftinor@gmail.com

Abstract. Research on the use of liquid natural latex for waterproof canvas fabric coatings has been carried out by varying the volume of liquid natural latex in 4 levels, namely 0.5 liters, 1.0 liter, 1.5 liters, 2.0 liter, and varying the thickness of the coating material 10 g, 20 g, 30 g so that 12 types of waterproof canvas are obtained. The purpose of this study was to find the right formula in the manufacture of canvas fabric that has the properties of Water Resistance, Adhesion, Tensile Strength, Elongation at Break, and Tear Resistance according to the quality standards of woven fabrics for tents. The results of testing the physical properties of waterproof canvas fabrics as a whole almost meet the quality standards of woven fabrics for tents, except for the results of the waterproof strength test at a layer of 10 g. The best results were obtained in formula III with a coating of 20 g, getting water resistance values of 43.6 mBar, adhesive strength 0.8 kg/cm, tensile strength 88.2 kg and 77.8, elongation at break 40.8% and 20, 3%, Tear strength 21.5 kg and 19.4 kg for warp direction and weft direction.

Keywords: canvas fabrics, natural latex, waterproof

1. Introduction
Canvas fabric is a heavy and strong woven fabric with plain webbing, the threads can be single, double, or twisted, made of cotton, hemp, synthetic fibers or a mixture thereof. Canvas fabrics are divided into three groups, namely heavy canvas used for industrial purposes, medium canvas for sails, postal bags, bags, truck covers, military purposes, such as tents, backpacks and others, light canvas used for shoes, umbrellas, household appliances and so on [1].

Several types of canvas are surface coated to resist water, are also attractive and have better chemical and physical resistance than ordinary materials, suitable for tents, backpacks, shoes, truck covers and more. Waterproof fabric is a fabric whose surface can hold water and air and can withstand hydrostatic pressure from the water column. The processing technique is very dependent on the type of fiber, for example fabrics from cellulose, synthetic, acetate, nylon, terylene and acrylate fibers [2].

The choice of coating material in the coating process is very important because the chemical and physical properties of the coating material will determine the quality of the resulting coating. There are several types of synthetic materials, such as aluminum salts, zirconium salts, aminoplasts and silicones which are commonly used to coat canvas fabrics [3].
The main product of rubber plants is latex which can be used to make various products, such as motor vehicle tires, rubber hoses, automotive components, gloves, medical/pharmaceutical devices, household appliances and others [4]. Natural rubber latex is a liquid latex from Hevea brasiliensis plant which is a natural polymer with isoprene monomer. This natural rubber polymer consists of 97% cis-1,4 polyisoprene polymer [5]. Latex is defined as a stable dispersion of polymeric substances, i.e. rubber polymers in a serum liquid containing various organic and inorganic compounds [6, 7].

The latex obtained from tapping the plant Hevea brasiliensis contains about 25 to 40 percent of raw rubber and 60 to 75 percent of serum (water and solutes). Raw rubber material contains 90 to 95 percent pure rubber, 2 to 3 percent protein, 1 to 2 percent fatty acids, 0.2 percent, Sugar, 0.5 percent of Na, K, Mg, P, Ca, Cu, Mn, and Fe salts. The suspended particles in latex serum are 0.04 - 3.06 microns in size [8, 9].

To increase the price of natural rubber raw materials in the country that is currently declining, it is necessary to conduct research by utilizing natural rubber raw materials for the manufacture of downstream rubber products that previously did not use natural rubber raw materials. One of them is a waterproof canvas fabric.

This study tried to use liquid natural latex as a coating material on polyester/cotton canvas fabrics with the addition of chemicals to get waterproof canvas fabrics.

The purpose of this study was to obtain the right formula for latex compounds in the manufacture of waterproof canvas fabrics that have water resistance, adhesion, tensile strength, elongation at break, tear strength and wear resistance according to quality standards of woven fabrics for tents [10].

2. Research and methodology
2.1. Materials and tools
The materials used in this study consisted of raw and auxiliary materials, namely Polyester/Cotton Canvas Fabric, Natural Latex, KOH, Ammonium Oleate, ZDEC, ZMBT, IONOL, ZnO and Sulfur [11]. While the equipment used is consisted of a ball mill, a mixer, a 25 x 40 cm screen, a 22 cm rackel, a drying oven, adhesive Strength test equipment, water Resistance, tensile Strength and tear Strength of the fabric.

2.2. Research method
In this study, experiments were carried out on the manufacture of 4 (four) latex compound formulas by varying the volume of latex with a dispersing agent (dissolving) as shown in Table 1, then experimenting with varying the thickness of the latex compound layer on canvas by 10 g, 20 g and 30 g

| Ingredients | I | II | III | IV |
|-------------|---|----|-----|----|
| KOH 10%     | 30 g | 30 g | 30 g | 30 g |
| Ammonium Oleate 7,5% | 40 g | 40 g | 40 g | 40 g |
| ZDEC 50% (dispersion) | 9.6 g | 9.6 g | 9.6 g | 9.6 g |
| ZMBT 50% (dispersion) | 8.4 g | 8.4 g | 8.4 g | 8.4 g |
| IONOL 50% (dispersion) | 12 g | 12 g | 12 g | 12 g |
| Sulfur 50% (dispersion) | 48 g | 48 g | 48 g | 48 g |
| ZNO 50% (dispersion) | 24 g | 24 g | 24 g | 24 g |
| Latex | 0.5 lt | 1.0 lt | 1.5 lt | 2.0 lt |

2.3. Work procedures
The working procedure/steps of the process of making waterproof canvas fabric can be seen in the flow chart in Figure 1.
2.3.1. Dispersion Process
Chemicals such as ZDEC, ZMBT, IONOL ZnO, and Sulfur were each made into a dispersion solution by weighing according to their respective formulas and then put into jars equipped with bullet pellets. The jar was tightly closed and rotated in a ball mill for 24 hours.

2.3.2. Latex compound manufacturing. Dispersed chemicals were mixed with concentrated latex, which had been centrifuged, added with KOH and Ammonium Oleate in a mixer machine, and stirred for 30 minutes. Then it was allowed to stand for 24 hours so that the mixture was more homogeneous so that a latex compound was formed.

2.3.3. Coating process. The latex compound coating process uses a printing press according to the sample size, and by using a rackel, the coating material is spread over the entire fabric surface by varying the latex compound layer material on the canvas by 10 g, 20 g, and 30 g.

2.3.4. Drying process. The cloth that has been coated with latex compound is then dried in an oven at 90°C for 15 minutes.

2.3.5. Parameters tested. In the form of water Resistance (mBar), adhesive Strength (kg/cm), fabric tensile Strength (kg), elongation at break (%) and tear Strength (kg).

3. Results and discussion
3.1. Water resistance
The results of the water resistance test can be seen in the histogram in Figure 2, where the water Resistance tends to increase with a decrease in the volume of latex or an increase in the concentration of latex compounds and latex layers.
Latex compound is a mixture of latex material that has gone through a centrifugation process with chemicals that have been dispersed, including ZDEC, ZMBT, ZnO, Ionol and Sulfur. Chemicals ZDEC and ZMBT are chemicals that function as accelerators, ZnO as an activator, sulfur as an ingredient for vulcanization, while Ionol as an anti-oxidant [12].

The more chemicals used in the manufacture of latex compounds, the chemical relationship between latex compounds and canvas fabric will be stronger and can cover the surface of the fabric more perfectly. It can be seen in Figure 2 that the increase in the volume of latex in the manufacture of latex compounds will reduce its resistance to water, while the more coating materials used for latex compounds cause the layer to become thicker so that water resistance increases. The maximum water resistance value of canvas cloth of 82.8 mBar was obtained in the latex compound formula I using a coating material of 30 g, while the minimum water resistance value of canvas cloth of 22.7 mBar was obtained in the latex compound formula IV using a coating material of 10 g. Compared with the quality standard of canvas fabric for tents, it shows that the water resistance value obtained from the experimental results of latex compounds formulas I, II, and III using 20 g and 30 g coating materials still meets the waterproof quality standards for webbing. fabric for tents, a minimum of 40 mBar.[13]

3.2. Adhesive Strength

Adhesive strength can describe the compatibility between the latex compound material and the fabric used, namely canvas or adhesion and cohesion and describe the durability of the coating product during use [14].

The results of the adhesive Strength test are shown in the histogram of Figure 3. The adhesive Strength also tends to increase with a decrease in the volume of latex or an increase in the concentration of latex compounds, while the latex layer does not reduce or increase the adhesive Strength between the latex compound and the adhesive canvas tends to remain.

Figure 2. Histogram of the waterproof canvas fabric water resistance.

Figure 3. Histogram of the waterproof canvas fabric adhesive Strength.
The increase in the value of adhesion between the latex compound and the fabric is due to the isoprene molecules in the latex compound that bind to the fabric fibers. The higher the concentration of latex compounds used, the more isoprene. The molecules in the latex compound are absorbed and bonded to the canvas fabric, so that the adhesive power will be higher [15].

The value of the maximum waterproof canvas adhesive strength of 1.1 kg/cm was obtained for the latex compound formula I using 10 g, 20 g, and 30 g coating materials, while the minimum waterproof canvas adhesive strength value was 0.7 kg/cm obtained for the compound. Latex formula IV uses 10 g, 20 g, and 30 g of coating material. Compared with the quality standard of canvas fabric for tents, it shows that the value of the adhesive strength obtained from the experimental results of latex compounds of formulas I, II, III and IV using 10 g, 20 g, and 30 g coating materials as a whole meet the quality standards for the adhesive strength of woven fabrics for tent, which is a minimum of 0.4 kg/cm [16].

3.3. Tensile strength

The results of testing the physical properties of water-resistant canvas fabric on tensile Strength as shown in Figures 4 and 5 tend to increase with a decrease in latex volume or an increase in the concentration of latex compounds and the thickness of the latex layer, both tensile Strength in the warp direction and tensile Strength in the weft direction.

![Figure 4. Histogram of the waterproof canvas fabric tensile Strength in the warp direction.](image)

The increasing value of the tensile Strength of the waterproof fabric with the increasing concentration of latex compounds used is caused by the increase in cross-linking between latex and chemicals and the canvas fabric used [17].

Tensile Strength is the energy required to pull canvas fabric and is an important and frequently performed physical test on canvas fabric. The maximum tensile strength value of the waterproof canvas fabric is 96.9 kg for the warp direction and 82.9 kg for the weft direction. It was obtained from the latex compound formula I using a coating material of 30 g. While the tensile strength of the waterproof canvas at least 83.7 kg for the warp direction and 73.1 kg for the weft direction was obtained in formula IV of latex compound using a coating material of 10 g. Compared to the quality standard of Canvas Fabric for tents, shows that the value of the tensile strength of the experimental result formulas of latex compounds I, II, III, and IV using coating material of 10 g, 20 g, and 30 g overall meet the quality standards for tensile strength of woven fabrics for tents of at least 50 kg for the warp direction and a minimum of 35 kg for the weft direction [18].
Figure 5. Histogram of the waterproof canvas fabric tensile Strength in the weft direction.

3.4. Elongation at break
The results of testing the physical properties of waterproof canvas fabric against elongation at break, as shown in Figure 6 and Figure 7, tend to increase with a decrease in latex volume or an increase in the concentration of latex compounds and the thickness of the latex layer, both warp and weft directions.

Similarly, the tensile Strength increases the elongation value at the break of the waterproof fabric with the increase in the concentration of latex compounds used due to the increased cross-linking density between latex and chemicals and the canvas fabric used [19].

Elongation at break in line with tension Strength is the energy required to pull the canvas material to break, which is expressed as % of the length of the specimen before stretching. And is a very important physical test of canvas fabric and is often done in addition to Tensile Strength.

The maximum breaking elongation value of waterproof canvas fabric is 42.9% for warp direction and 19.8% for the direction of the weft obtained in the latex compound formula IV using a coating material of 10 g.

Figure 6. Histogram of the waterproof canvas fabric elongation at break in the warp direction.
3.5. Tear strength

The results of testing the physical properties of waterproof canvas fabric against tear strength as shown in Figures 8 and 9, tend to increase with a decrease in latex volume or an increase in the concentration of latex compounds and the thickness of the latex layer, both in the warp and weft directions. The increase in the tear strength of the fabric in both the warp direction and the weft direction is the same as the tensile strength, due to the increase in the number of cross-links in the latex compound in the vulcanization process [21].

Tear strength is the energy required to tear canvas material and is the most important and frequently performed physical test of canvas fabric besides the tensile strength and elongation of textile materials. The maximum tear strength value of the waterproof canvas fabric is 24.3 kg for the warp direction and 22.0 kg for the weft direction. It was obtained from the latex compound formula I using a coating material of 30 g.

Figure 7. Histogram of the waterproof canvas fabric elongation at break in the weft direction

Compared with the quality standard of canvas fabric for tents, it shows that the elongation value at break obtained from the experimental results of latex compound formulas I, II, III, and IV using 10 g, 20 g, and 30 g coating materials overall meets the quality standard woven fabric for tents, which is a minimum of 33% for the warp direction and 10% for the weft direction.[20]
While the minimum tear strength value of waterproof canvas fabric is 19.6 kg for the warp direction and 16.8 kg for the weft direction obtained from the latex compound IV formula using a coating material of 10 g. Compared with the quality standards of woven fabrics for tents, it shows that the tear strength values obtained from the experimental results of latex compound formulas I, II, III, and IV using coatings of 10 g, 20 g, and 30 g overall meet the quality standards of woven fabrics for tents, which are minimal. 10 kg for warp direction and 4 kg for weft direction [22]

3.6. Wear resistance
Obsolescence results in a decrease in the physical properties of finished rubber, caused by the degradation of rubber due to oxidation by oxygen and ozone. Oxidation is accelerated in the presence of heat, moist ultraviolet light and the metal catalyzing the oxidation. The wear Resistance test aims to determine the deterioration of the physical properties of waterproof canvas fabrics, such as water Resistance and adhesive Strength.

**Table 2.** Testing results of waterproof canvas fabric wear process for coating material 10 g.

| No | Type of Test            | Test Results per Formula |
|----|-------------------------|--------------------------|
|    |                         | I | II | III | IV |
| 1. | Waterproof (mBar)       | 30.5 | 30.1 | 24.9 | 21.8 |
| 2. | Adhesive Strength (Kg/cm)| 1.0 | 0.9 | 0.7 | 0.6 |

**Table 3.** Testing results of waterproof canvas fabric wear process for coating material 20 g.

| No | Type of Test            | Test Results per Formula |
|----|-------------------------|--------------------------|
|    |                         | I | II | III | IV |
| 1. | Waterproof (mBar)       | 61.9 | 58.8 | 41.4 | 34.1 |
| 2. | Adhesive Strength (Kg/cm)| 1.0 | 0.9 | 0.7 | 0.6 |

**Table 4.** Testing results of waterproof canvas fabric wear process for coating material 30 g

| No | Type of Test            | Test Results per Formula |
|----|-------------------------|--------------------------|
|    |                         | I | II | III | IV |
| 1. | Waterproof (mBar)       | 78.7 | 74.6 | 46.8 | 37.1 |
| 2. | Adhesive Strength (Kg/cm)| 1.0 | 0.9 | 0.7 | 0.6 |
The results of the canvas water resistance test after the wear resistance process as shown in Table 2, Table 3, and Table 4 tend to experience a decrease in both latex volume and coating thickness ranging from 4% to 8%. The decrease in the value of water resistance is caused by cross-linking reactions and oxidation reactions which break the latex molecular chain so that the coating becomes brittle. However, the water resistance value on canvas with a coating of 20 g and 30 g for formulas I, II and III still meets the quality standard for woven fabrics for tents, which is at least 40 mBar [23]. Whereas the value of water resistance on canvas with a coating of 10 g for formulas I, II, III and IV does not still meet the quality standards of woven fabrics for tents because the value is below 40 mBar.

The results of testing the adhesive strength of waterproof canvas fabric after the wear resistance process, as shown in Table 2, Table 3, and Table 4 also tend to decrease both for latex volume and layer thickness ranging from 7% to 10%. The decrease in the value of the adhesive strength is equal to the decrease in water resistance caused by the occurrence of cross-linking reactions and oxidation reactions during heating. However, the value of the adhesive strength on canvas with a coating of 10 g, 20 g, and 30 g for formulas I, II, III, and IV still meets the standard for woven fabrics for tents, which is a minimum of 0.4 kg/cm [24].

4. Conclusions and suggestions
Liquid natural latex can be used as a coating material in the manufacture of waterproof canvas fabrics, increasing the chemicals used in the manufacture of latex compounds and the thickness of the coating material can improve the physical properties of water resistance, adhesive strength, tensile strength, elongation at break and tear strength of waterproof canvas fabrics.

The best results and meet the quality standards for woven fabrics for tents were obtained from the latex compound formula III with a coating of 20 g, getting a water resistance value of 43.6 mBar, adhesive strength 0.8 kg/cm, tensile strength 88.2 kg, and 77.8 kg, elongation at break 40.8% and 20.3%, tear strength 21.5 kg and 19.4 kg for warp and weft directions.

Further research is needed to make waterproof fabrics from other materials such as rayon and nylon using natural latex as a coating material.

Acknowledgments
The authors would like to thank the Head of the Palembang Industrial Research and Standardization Center and the Head of the Indonesian Center for Estate Crops Research and Development for their participation and implementation 2nd International Conference on Sustainable Plantations.

References
[1] Jumaeri, Wagimun, Rasyid J, Okim, D and Hasan, G, 2012, Textile Good Knowledge, Bandung, Textile Technology High School
[2] Suparman, Surdia, NM and Budiarti, 2014, Textile Enhancement Technology, Bandung, Textile Technology High School
[3] Wibowo, M, Isminingsih, Budiarti and Widayat, 2011, Chemical Textile Evaluation, Bandung, Technology High School
[4] Sansatsadeekul, J., Sakdapipanich, J., & Rojruthai, P. 2011. Characterization of associated proteins and phospholipids in natural rubber latex. Journal of bioscience and bioengineering, 111(6), 628-634.
[5] Popy, M and Hari, AP, 2017, Characteristics of rubber sheet with the raw material of composite modifications latex, Journal of Industrial Research Dynamics, 28 (2) 112-119
[6] Tho, N. V., Kadir, M. O., and Hashim, A. S. 2012. A Comparative of Styrene Polymerization in Deproteinized and Undeproteinized Natural Rubber Latex. Rubber Chemistry and Technology. 75(1): 111-118.
[7] Nurhayati, C., & Andayani, O. 2015. Concentrated latex processing using curd process using alginate salt extracted from seaweed for foam products. Journal of Industrial Research Dynamic 26(1), 49-58
[8] Cifriadi, A., Budianto, E., & Alfa, Characterization of cyclo rubber based on low molecule weigh natural rubber latex, *Journal of Rubber Research*, 29(1), 35-48

[9] Ravindran, T., Nayar, M., & Francis, D. J. 2014. Production of hydroxyl-terminated liquid natural rubber mechanism of photochemical depolymerization and hydroxylation. *Journal of applied polymer science*, 35(5), 1227-1239.

[10] National Standardization Agency, 2010, SNI 08-2159-2010, *Woven Fabrics for Tents*.

[11] Anonymous, 2006, Training on Latex Finished Goods Technology, Bogor, Bogor Rubber Technology Research Institute

[12] Herminiwati and Arum Y, 2012, Use of PCC as a Filler for Rubber Soles of Sports Shoes, *Plastic Rubber Leather Magazine*, Vol. (26) 1: 25-32

[13] National Standardization Agency, 2010, SNI 08-2159-2010, Woven Fabrics for Tents.

[14] Hassim N, Ahmad MR Yahya 2011, Puncture Resistance of Natural Rubber Latex Unidirectional Coated Fabrics, *Journal of Industrial Textile* 40 (3): 420-429

[15] Nuraya, ASS, Baharin, A, Azura, AR, dan Hakim, MH, 2012, Reinforcement of pre vulcanized natural rubber latex film by banana stem powder and comparison with silica and calcium carbonate, *Journal of Rubber Research*, 15 (2) : 124-140

[16] National Standardization Agency, 2010, SNI 08-2159-2010, Woven Fabrics for Tents

[17] Mohamed, M, 2017 Properties of Cellulosic FabricTreated by Water Repellent Emulsions, *Indian Journal of Fiber and Textile Research* 42, 223-229

[18] National Standardization Agency, 2010, SNI 08-2159-2010, *Woven Fabrics for Tents*

[19] Indiah, RD and Hemiriwati, 2014, Natural Rubber Latex for Shoe Soles Manufacturin Methods, Mechanical Properties and Morphology, *Leather Magazine, Rubber and Plastics*, Vol. 30(2) 61-70

[20] National Standardization Agency, 2010, SNI 08-2159-2010, *Woven Fabrics for Tents*

[21] Sasidharan, KK, Joseph, R, Palaty, S and Pillai, PV, 2013, Effect of vulcanization time and storage on the stability and physical properties of sulfur pre vulcanized natural rubber latex, *Journal of Applied Polimer science*, 97 (1) 1804-1812

[22] National Standardization Agency, 2010, SNI 08-2159-2010, *Woven Fabrics for Tents*

[23] National Standardization Agency, 2010, SNI 08-2159-2010, *Woven Fabrics for Tents*

[24] National Standardization Agency, 2010, SNI 08-2159-2010, *Woven Fabrics for Tents*