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# Cream concentrated latex for foam rubber products

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**Abstract.** Fresh natural latex (around 40% rubber and 60% water) can be transformed to concentrated natural latex (around 60% rubber and 40% water) in order to realise economical transportation and easier latex product's preparation. The concentrated natural latex is an extremely valuable material. It can be applied for many types of products, for example, foam rubber as pillow and mattress, elastic band, etc. Industrially, the concentrated natural latex can be prepared by centrifugation which requires an enormous expensive machine. From the eco-friendly products point of view, most of rubber entrepreneurs in the world try to develop a green rubber product. So, the main objective of this study is to prepare the cream concentrated latex without any sophisticated machine. Thus, we work on a simple, cheap and green method that does not use any expensive machine but uses water-based chemical as sodium alginate to prepare the cream concentrated latex. The optimal amount of sodium alginate in the latex was studied. The main characteristics of the cream concentrated latex were tested by various technics, such as alkalinity, total solid content (TSC), dry rubber content (DRC), etc. We found that there are no significant differences of results between fresh natural latex and cream concentrated latex, except for the TSC and DRC. The TSC and DRC of cream latex are higher than those of fresh natural latex. Finally, we propose a model of natural rubber particle and sodium alginate to form the cream concentrated latex.

## 1. Introduction

Natural rubber is made from runny milky white liquid called latex. Although there are something like 200 plants in the world that produce latex, however, the world's natural rubber is industrially made from the latex that comes from a specific tree species called *Hevea brasiliensis*. Fresh natural latex can be collected from a tapped rubber tree. Fresh natural latex is a colloidal system of natural rubber particle in micron size dispersed in an aqueous medium and contain 30-40% of dry rubber content (Table 1) [1-2].

Composition of fresh natural latex depends on factors such as soil condition, fertilizer quality, tapping system, season, etc. Fresh natural rubber latex can be contaminated by micro-organism because natural latex contains various nutritious substances, otherwise known as non-rubber components [3-4]. The micro-organism consumes these non-rubber constituents and then generates the volatile fatty acid

(VFA) which enables the destabilisation of latex particles. Normally, we use ammonia solution to neutralise the VFA in the latex that keep the stabilization of latex. So, ammonia solution is used to preserve the natural latex. Fresh natural latex can be transformed to concentrated natural latex in order to maintain the constant quality of concentrated natural latex and to generate the economic value for latex's transportation.

**Table 1.** Composition of fresh natural latex.

| Constituent | % by weight of latex |
|---|---|
| Rubber particles | 30-40 |
| Protein | 2-3 |
| Lipids | 0.1-0.5 |
| Sugars | 1-2 |
| Ash | 0.5-1.0 |
| Others | 1.5-3.5 |
| Water | 55-65 |

Concentrated natural latex contains 60% rubber, which is essential in making products such as foam rubber as pillow and mattress, elastic band, etc [5]. The concentrated natural latex can be produced by various processes including evaporation, electrocantation, centrifuging and creaming. Evaporation refers to the removal of water by floating a double-walled cylindrical vessel and a hollow iron roller in the latex and spray hot latex into partially evacuated chamber. Electrocantation immerses positive electrode into latex. As a result, the positive was combined and would float up on the surface of latex. Centrifuging, in which the latex is placed into a centrifuge and later it is centrifuged to remove some of the water in order to increase the rubber content of latex.
The centrifugation process for concentrated natural latex is very well known and is used widely for commercial purpose, but it uses a big, expensive machine and adding chemical agent (TMTD) to preserve the natural latex that cause the cancer from nitrosamine. One of the methods for preparing concentrated natural latex is creaming, the creaming method is a chemical process that mixes creaming agent and fresh natural latex and facilitates phase separation (rubber fraction and serum). Creaming agent helps in increasing the creaming efficiency. Cream concentrated latex was successfully prepared using a creaming agent include sodium carboxymethyl cellulose, poly(vinyl alcohol), methyl cellulose, carboxymethyl cellulose, locust bean gum, tamarind seed powder, casein and sodium alginate [6-7]. This method is environmentally friendly for it requires simple equipment and incurs lower power consumption. The main objective of this paper is to prepare the cream concentrated latex using sodium alginate as a creaming agent. Various properties of the cream concentrated latex were characterized and compared with the fresh natural latex. This aspect has not been reported in the previous literature reviewed.

## 2. Experimental

### *2.1. Materials*
Fresh natural latex was kindly collected from plantation in the southern of Thailand (Tha chang industries group, Suratthani). The characteristics of latex are in the table 2. Sodium alginate was supplied from Thanodom trading, Thailand. Ammonia solution was supplied from RCL Labscan, it was used as a latex preservative against bacteria attack and yo provide long-term stability..

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**Table 2.** Characteristics of latex.

| Materials | Characteristics | | Sources |
|---|---|---|---|
| Fresh natural latex | TSC | 37.17% | Tha chang industries, Thailand |
| | DRC | 27.28% | |
| Centrifuged concentrated latex | TSC | 61.71% | Tha chang industries, Thailand |
| | DRC | 60.13% | |

*2.2. Preparation of cream concentrated latex using sodium alginate*
Dissolved 3 g of sodium alginate (creaming agent) in 100 ml of distilled water. Varies of 1, 2, 3, 4 and 5 ml of the sodium alginate solution was transferred into beaker containing 25 ml of latex and then agitation for 30 min. Incubation at room temperature and leave it undisturbed for 3 day, observing that the latex separated into two layers after 1 day and allowed the rubber particles (cream phase) to move up through a period of several weeks. When the separation is completed, the aqueous serum phase is run off leaving only the upper rubber fraction.

*2.3. Characterizations of the fresh natural latex and cream concentrated latex*
Analysis and testing of latex properties include total solid content (TSC), dry rubber content (DRC), Alkalinity (%), Volatile fatty acid (VFA) and Mechanical stability (MST) as shown below.

*2.3.1. Total solid content (TSC) (ISO, 124).* Pour 2 g of latex into the dish and determine the exact mass by weighing, approximate to the nearest 0.1 mg, then place the dish in the oven at 105 $\pm 5^{o}$C for 2 h, or until the test portion has lost its whiteness. Remove the dish from the oven and allow it to cool to ambient temperature.

*2.3.2. Dry rubber content (DRC) (ISO 126).* 10 $\pm 1$ g of latex concentrate into dish. Add of 20 g/dm$^3$ acetic acid solution, pouring it down along the inner edge of dish and slowly rotating the dish while the acid is being added. When the serum is clear, collect any small particles of coagulated rubber by rubbing with the main bulk. Soak the coagulated rubber in several change of water until the water is no longer acidic to litmus, after that running of water for at least 5 min. Dry the sheet at 70 $\pm 5$ ℃ until it has no white patches.

*2.3.3. Alkalinity (%) (ISO, 125).* A test portion of latex is titrated with acid to pH 6 in the presence of a stabilizer to prevent coagulation, either electrometrically or with methyl red as a visual indicator. The alkalinity is calculated from the quantity of acid required.

*2.3.4. Volatile fatty acid or VFA (ISO, 506).* A test portion is coagulated with ammonium sulphate and a portion of the resultant serum is separated and acidified with sulphuric acid. The acidified serum is steam-distilled and the volatile acids present in the test portion are determined by titration of the distillate with a standard volumetric barium hydroxide solution

*2.3.5. Mechanical stability (MST) (ISO, 35).* A test portion of latex is diluted to 55% by mass total solids content and stirred at high speed. The time required to initiate visible flocculation is recorded, this regarded as a measure of the mechanical stability.

## 3. Results and discussion

When fresh natural latex was added the creaming agent, two layers of latex appeared or we can call it "the creaming phenomenon". The upper layer is cream concentrated latex, it was then added ammonia solution with a concentration of 0.6% for its preservation. On the other hand, the lower fraction is serum that is separated from the cream latex by gravity with the activity of the added creaming agent.

### *3.1. Quantity of creaming agent for preparation of cream concentrated latex*

Figure 1 presents the quantity creaming agent at 1, 2, 3, 4, and 5 ml in the fresh natural latex at 25 ml. The creaming phenomenon was observed at different incubation times. This figure shows the relationship between incubation time and quantity of creaming agent. We found that incubation time is decreased with increasing of creaming agent then reached at a constant value of incubation time for 4 ml of creaming agent. So, the optimal quantity of creaming agent is 4 ml in fresh natural latex 25 ml, this optimal ratio will be applied for the other sections.

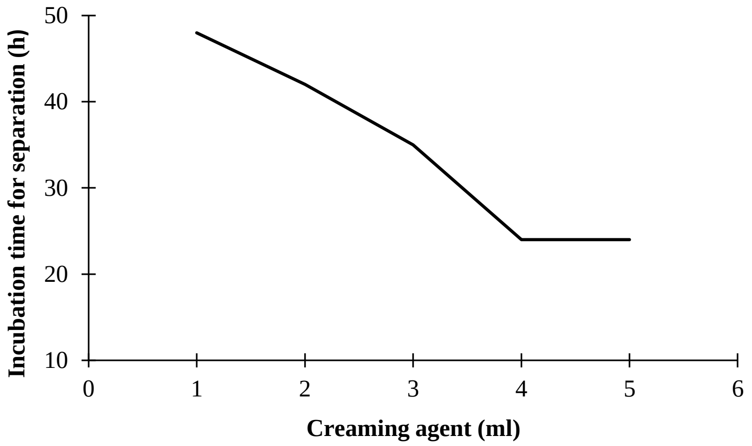


**Figure 1.** Relationship of quantity of creaming agent and incubation time (h)

### *3.2. Properties of cream concentrated latex*

Characterizations of fresh natural latex and cream concentrated latex were compared in table 3. When fresh natural latex is transformed to concentrated natural latex by creaming process using sodium alginate as a creaming agent, we found that TSC and DRC values of the cream concentrated latex are clearly higher than those of fresh natural latex. This proves that the sodium alginate provides efficiency to separate rubber particles from the serum solution. However, there are no significant differences of alkalinity and VFA between fresh natural latex and cream concentrated latex. The cream concentrated latex was still incubated just 3 days with 4 ml of creaming agent. The alkalinity indicates to the ammonia level in latex and the VFA indicates to the degradation of latex by micro-organism. The results from table 3 mean that both types of latex are in good condition and are not yet degraded.

**Table 3.** Properties of fresh natural latex and cream concentrated latex.

| Properties | Fresh natural latex | Cream concentrated latex |
|---|---|---|
| Total solid content (%) | 37.17 | 46.31 |
| Dry rubber content (%) | 27.28 | 44.61 |

| | | |
|---|---|---|
| Alkalinity (%) | 0.67 | 0.14 |
| Volatile fatty acid or VFA | 0.042 | 0.031 |

*3.3. Effect of incubation time on TSC and DRC*

Figure 2 shows TSC and DRC values of cream concentrated latex with incubation time. The TSC and DRC values of cream concentrated latex increased in the first month and then reached the plateau constant value with longer period of incubation time. The TSC value is always higher than DRC value because TSC includes rubber and non-rubber components, while the DRC presents only rubber component.

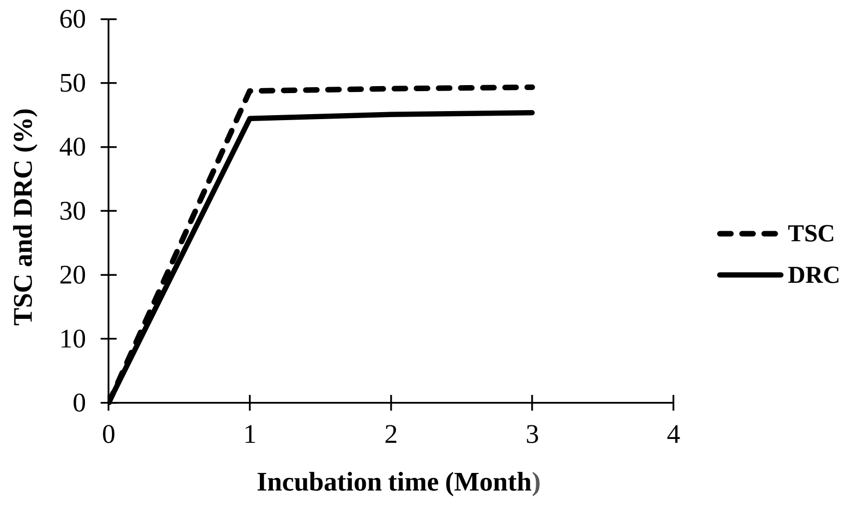


**Figure 2.** Relationship of TSC and DRC of cream concentrated latex and incubation time (Month).

*3.4. Effect of incubation time on MST of cream concentrated latex.*

Mechanical stability or MST level relates to incubation time as in the figure 3, indicates that cream concentrated latex has higher MST with increasing incubation time or storage time. This is attributed to the increase fatty acid soap from hydrolysis of the phospholipid and ammonia solution [6]. It has been known that the fatty acid soap is adsorbed at the surface of rubber particle to form hydration layer to cover rubber particle [8]. This affects the enhancement of the colloid stability of the latex and thus increasing MST.

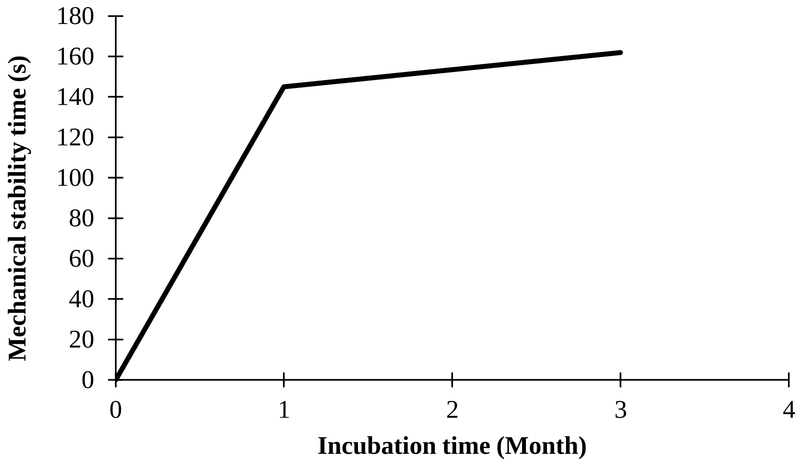


**Figure 3.** MST of cream concentrated latex and incubation time (Month).

*3.5 Model of relation between sodium alginate*

Sodium alginate is used as a creaming agent with high degree of polarity (hydroxyl group, -OH) and sequences of the mannuronate and glucuronate residues (figure 4). The sodium alginate can become hydrophilic colloids dispersed in the latex and interacts with the rubber particles through the negative charges at the surface of particles (figure 5).

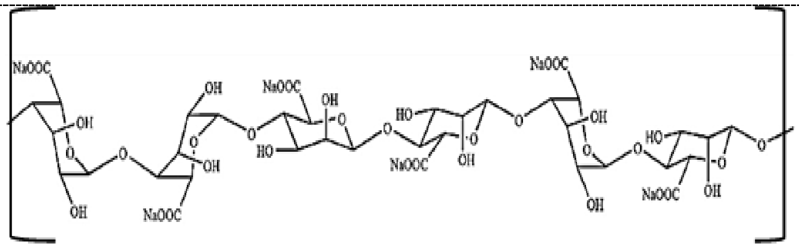

**Figure 4.** Molecular structure of sodium alginate.

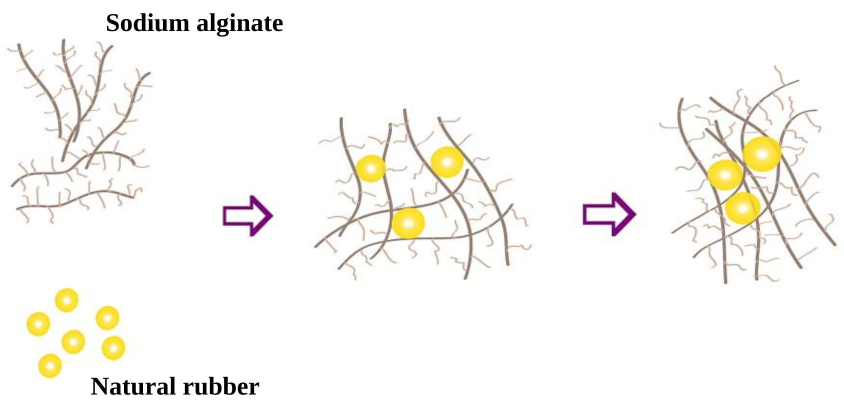


**Figure 5.** Ideal model structure of cream concentrated formation (a) surface of rubber particles interaction with sodium alginate molecule and (b) entanglement of sodium alginate molecules with rubber particles.

The sodium alginate molecules cover the surface of rubber particles (figure 5), more adsorption of sodium alginate molecules at the surface of rubber particles with longer incubation time. The branched segments of the sodium alginate molecule could be entangled with the sodium alginate in neighbouring rubber particles, this causes larger size of rubber particle. High molecular weight sodium alginate with a number of hydroxyl groups (OH) led to higher viscosity of the latex and cause to slowly movement of rubber particles [6].

## 4. Conclusions
We have succeeded in preparing the concentrated natural latex using creaming technic with the optimal amount of creaming agent. Cream concentrated natural latex using sodium alginate as a creaming agent represented higher TSC and DRC compared to the fresh natural latex. The other properties of both types of latex show no significant differences, except for the MST of cream concentrated latex increasing with the increase of incubation time. We also propose a model to explain the cream concentrated latex between sodium alginate and rubber particles. This type of concentrated latex could be applied for the foam rubber products, especially green rubber products.

## 5. Acknowledgments
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