Preparation of powder rubber from fresh natural rubber latex

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Title	Preparation of powder rubber from fresh natural rubber latex
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Field of Study	Petrochemical Engineering
Advisor	Assoc. Prof. Dr. Kriangsak Kraiwattanawong

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Abstract

In general, the production to transform the natural rubber latex (NRL) as a material for the industry has many steps through several stages. The production was waste time and uses a lot of energy resulting the high cost in the industry. This research is to study the preparation powder rubber from natural rubber latex by spray drying method which is an alternative way to reduce the step of rubber processing, energy and time in the industry. The study variable is nozzle flow rate to study the effect of the diameter of the powder rubber obtained from the nozzle flow rate. The experiment was operated under condition: the inlet temperature 130 °C, a feed rate of 4 ml/min., 15% dry rubber content (DRC) and 12 parts per hundred of rubber (phr) of N70 (Texapon, Sodium Lauryl Ether Sulfate). The NRL used in the experiment was mixed with 2 M sodium hydroxide solution to preserve the latex from coagulation. Scanning Electron Microscope (SEM) analysis showed that when increasing the nozzle flow rate the diameter size of powder rubber decrease.

Keywords: Natural rubber, latex, powder rubber, spray drying

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บทคัดย่อ

โดยปกติการแปรรูปน้ำยางเป็นยางแห้งเพื่อเป็นวัตถุดิบของอุตสาหกรรมต้องผ่านขั้นตอนหลายขั้นตอน ซึ่งใช้พลังงานมากและสิ้นเปลืองเวลา ส่งผลให้ต้นทุนทางด้านอุตสาหกรรมสูง งานวิจัยนี้ทำการศึกษาการผลิตยางผงจากน้ำยางธรรมชาติโดยเครื่องพ่นแห้ง ซึ่งเป็นทางเลือกหนึ่งในการลดขั้นตอนกระบวนการแปรรูปยางพารา ตัวแปรที่ใช้ในศึกษาคือ อัตราการไหลของอากาศที่ค่าต่างๆ เพื่อศึกษาขนาดเส้นผ่านศูนย์กลางของยางผงที่ได้จากการเปลี่ยนแปลงอัตราการไหลของอากาศ โดยกำหนดให้อุณหภูมิขาเข้ามีค่า 130 องศาเซลเซียส อัตราการป้อนน้ำยาง 4 มิลลิลิตรต่อนาที ร้อยละของเนื้อยางแห้งในน้ำยางคือ 15 และปริมาณของสารลดแรงตึงผิวชนิดโซเดียมลอริลซัลเฟต 12 ส่วน โดยนำน้ำยางธรรมชาติที่ใช้ในการทดลองมาผสมกับสารละลายโซเดียมไฮดรอกไซด์เข้มข้น 2 โมลาร์ เพื่อรักษาสภาพของน้ำยางไม่ให้เกิดการจับตัวกันเป็นก้อน จากการวิเคราะห์ด้วยกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราด พบว่าอัตราการไหลของอากาศส่งผลต่อขนาดเส้นผ่านศูนย์กลางของยางผง โดยเมื่อเพิ่มค่าอัตราการไหลของอากาศ จะส่งผลให้ได้ค่าขนาดเส้นผ่านศูนย์กลางของยางผงลดลง และเมื่อลดค่าอัตราการไหลของอากาศ ขนาดของยางผงมีแนวโน้มเพิ่มขึ้น

คำสำคัญ: ยางธรรมชาติ,ยางผง,เครื่องพ่นแห้ง

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Miss Suchanun Khwanjaroen

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CHAPTER I
INTRODUCTION

1.1 Background

Natural rubber latex (NRL) is the product from *Hevea brasiliensis* (rubber trees). Currently, rubber trees are grown widely in Thailand. Natural rubber obtained from rubber trees is in the form of natural rubber latex and it has been processed into products for sale with both in the form of rubber latex and dry rubber, which these rubber are used to produce many types such as rubber gloves, tires, rubber pillows, various components in cars. Normally, the processing of natural rubber latex into dry rubber as a raw material for the industry, it is necessary to go through several steps: making the latex coagulation, sheet rolling, drying the rubber. When it was forwarded to the industry to produce material, it must be cleaned again to clear the dirt mixed with rubber debris such as dust and other unwanted debris that attached with the rubber sheet. Then bake again for dry tires and humidity in the rubber was reduced. Following with the process of cutting rubber into small pieces, all of these processes require chemicals such as rubber-forming compounds, fillers, etc. Mixing rubber with such chemicals is difficult and all of the energy consumed in mixing, pressing, pulling and shearing that makes the rubber are weak and torn. In addition, these processes will reduce the physical properties of the rubber, wasting time and consuming a lot of energy be the cause of the high cost of industry.

When the production increase of natural rubber latex the cause of the price of natural rubber latex. Changing fresh natural rubber latex to powder natural rubber uses an alternative to use the natural rubber latex in the continuous production.

The powder natural rubber is prepared from the fresh natural rubber latex to ease of use. The natural rubber latex was passing through the process in the form of powder natural rubber. Powder rubber form, it can be easy using in continuous production or using as the addition in polymer industries and it can be used immediately without grinding or cutting rubber.

This research is to study the changing form of natural rubber from natural rubber latex to powder rubber form in order to reduce the steps in the rubber production process. This experiment would study about the methodology to determine the distribution of particle size diameter of the powder natural rubber with spray drying method by the variable used in the experiment is nozzle flow rate at various values. The powder natural rubber from the process was analyzed using the scanning electron microscope (SEM).

1.2 Objective

To determine the particle size distribution of the powder rubber from fresh NRL prepared by spray drying method at various nozzle flow rate.

1.3 Scopes of Work

1.3.1 Sodium hydroxide (NaOH) is solution to preserve the latex from coagulation.

1.3.2 The concentration of sodium hydroxide is 2 M.

1.3.3 Use spray drying method to produce powder rubber

1.3.4 The study variable is nozzle flow rate.

1.3.5 Use scanning electron microscope (SEM) to study the effect of nozzle flow rate on the diameter of powder rubber.

1.4 Expected Outputs

Preparation of powder natural rubber from fresh natural rubber latex using the spray drying method by the study variable is the nozzle flow rate. This methodology can give the different particle size of powder natural rubber.

CHAPTER II
THOERY AND LITERATURE REVIEW

In this chapter, theories that relevant research are presented, including the properties of natural rubber, the centrifuge process of natural rubber, the preservation of natural rubber, and literature review.

2.1 Natural rubber latex

2.1.1 Source of natural rubber latex

The natural rubber latex is the portion of cytoplasm inside the latex tube of the rubber tree. The natural rubber latex could be extruded by drilling or slitting.[1] Many nuclei are attached next to the rubber tube but rarely found in the latex after slitting. It is possible that the nucleus has an important role in controlling the formation of natural rubber latex. [2]

Figure 2.1 Parts of natural rubber latex within the latex tube. [3]

The mitochondria can detect large volumes stuck inside the rubber tube but the volume is reduced when the latex tube age. In rubber latex, this can be slit from the rubber tree to find less of mitochondria. The part of the latex tube, the tube is formed by the cell. At the end of each cell will penetrate. And it is connected to each other as a net. View along the trunk, longitudinal tubing can be found and connected several pipes. The rubber tube from one pipe can flow to another pipe. When the rubber tubes are cut from the rubber, latex comes out as fresh natural rubber latex. [1]

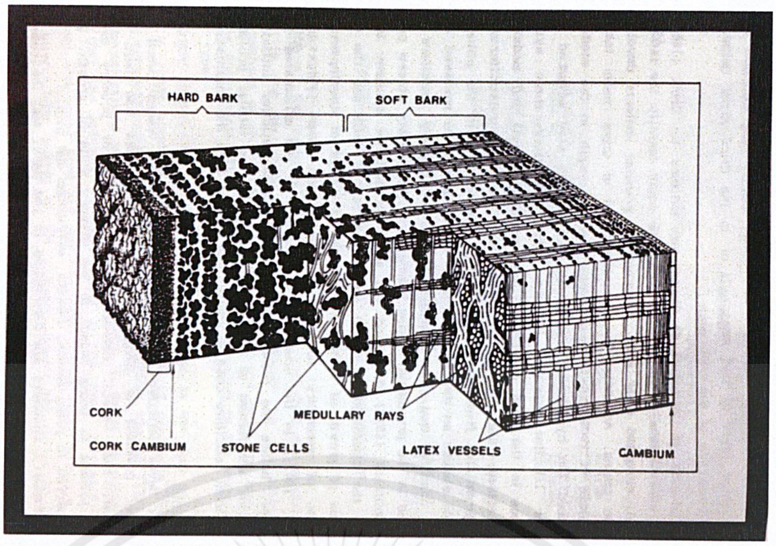

Figure 2.2 The characteristics of the rubber tube formed by the cell. [3]

The natural rubber latex is a mixture of at least two components, the part of suspension (disperse phase) scattered in the intermediary (disperse medium). Typically, the natural rubber latex is a milky white liquid like milk, flow easily. The liquid state of the natural rubber latex comes from the state of the medium which is water.

Most Natural rubber latexes were suspended in the medium without dissolving (lyophobic sols). Considering only aqueous lattices, it is classified as a mixture of water-mediated mixtures (hydrophobic sols). Characteristics of different natural rubber latex (type lyophobic sols) from other compounds is the nature of the scattered part, which is not dissolved with the liquid medium that it is suspended to make rubber latex in lyphobic sols form more than lyophilic sols form. [4]

2.1.2 Properties, structure and composition of natural rubber

The natural rubber latex is supplied by the plantation. It looks like a milky white liquid that is shown in Figure 2.3. Natural rubber latex is colloidal or suspension solution. The density was between 0.975 - 0.980 g / ml. natural rubber latex has pH of about 6.5 to 7. The viscosity of natural rubber latex is about 12 -15 centipoise (purified water has a viscosity of 1 centipoise) and it may vary depending on the amount of components in the latex. It also depends on factors including age, the season that slitting the rubber and etc. [1]

Figure 2.3 *Hevea brasiliensis* (rubber trees) and natural rubber latex.

The rubber hydrocarbon component in natural rubber latex consists of over 99.99% of linear cis-1,4 polyisoprene. As already mentioned, the trans-1,4 polyisoprene has entirely different properties than NR. From research into synthetic rubbers, it is also known that a small amount of trans-configuration of a few percents only, results in greatly different properties of cis-polyisoprene. The average molecular weight of the polyisoprene in NR range from 200000 to 400000 with a relatively broad molecular weight distribution. This corresponds to about 3000 to 5000 isoprene units per polymer chain. As a result of its broad molecular weight distribution, NR has an excellent processing behavior. [5]

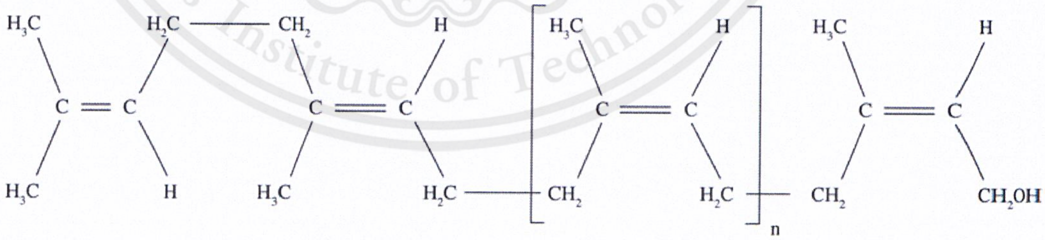

Figure 2.4 Chemical structure of cis-1,4-polyisoprene from natural rubber. [6]

The natural rubber is consisting of rubber particle and non-rubber particles suspended in an aqueous serum phase. The average rubber particle content of latex may range between 30% and 45%; the typical composition of fresh latex is shown in Table 2.1. [7]

Table 2.1 Typical composition of fresh latex and dry rubber [7]

	Latex,%	Dry rubber,%
Rubber hydrocarbon	36	93.7
Protein	1.4	2.2
carbohydrates	1.6	0.4
Neutral lipids	1.0	2.4
Glycolipids + phospholipids	0.6	1.0
Inorganic constituents	0.5	0.2
Others	0.4	0.1
water	58.5	-

In the part of the non-rubber particle in natural rubber, some of these non-rubber substances greatly influence the properties of natural rubber. The properties affected by the non-rubber substances are summarized in Table 2.2

Table 2.2 Properties of natural rubber influenced by non-rubber substances [7]

Property	Influence of the non-rubbers
Latex stability	Carbohydrates act substrates for bacterial growth-lead to increased volatile acid formation and lower stability
Color	Yellow-caused by β-carotenes. Dark-enzymic reaction of polyphenol oxidase.
Cure	Phospholipids and some proteins are natural accelerators; fatty acids are activators.
Oxidation	Tocotrienols are natural antioxidants. Copper, manganese and iron ions are pro-oxidants.
Storage hardening	Proteins and free amino acids react with abnormal groups in rubber.
Crystallization	Unstrained crystallization rate increased by stearic acid, some water-soluble substances retard rate.
Creep and stress relaxation	High contents of proteins and ash lead to moisture absorption, which results in high creep and stress relaxation in vulcanizates.
Modulus	Increased by proteins.
Filler effect	Proteins act as fillers. One part of the protein is equivalent to 3 parts of HAF black.
Heat build-up	Heat build-up in the Goodrich flexometer test is decreased by fatty acids and increased by proteins.
Tear strength	Increased by proteins.

Normally, the natural rubber when left with no additives put into it. The natural latex would begin to lose its latex condition. The important factors that make natural rubber latex loss of condition are environment, temperature, the growth of bacteria in natural rubber latex because when bacteria eat non-rubber substance like sugar, protein and etc. to increase the amount of bacteria in the latex. The degradation of the rubber from bacteria gives acid when the amount of acid was increased; the pH of the latex was changed causes the latex to become the coagulation. [1]

The centrifuge process, which now accounts for about 93 percent of latex concentrate production is based on the modification of milk separators for use with rubber latex. [7] When latex is applied with the high-speed centrifuge, it could be separated into 4 layers. [8] That was shown in figure 2.5

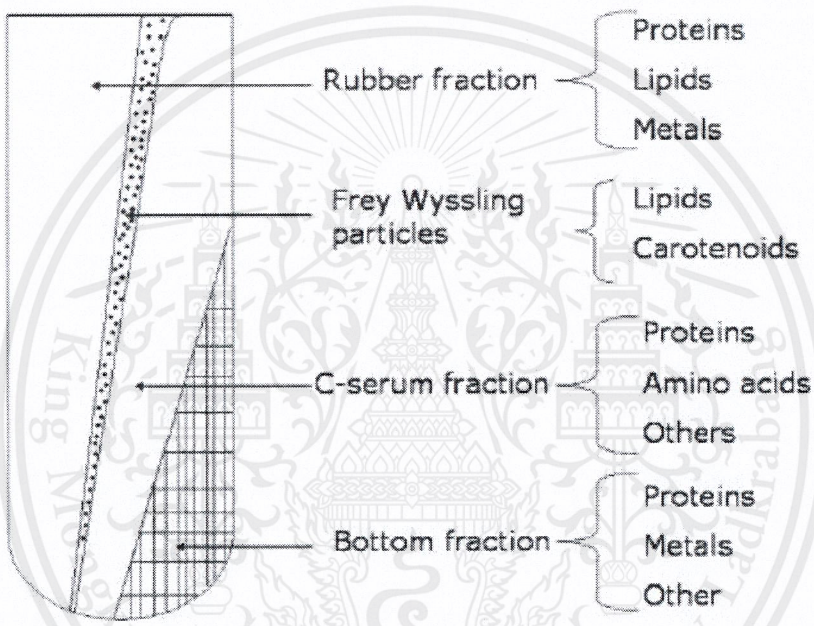

Figure2.5 Layer of natural latex after centrifugation at high speed. (12000 rpm) **[9]**

Figure 2.5 is shown the layers of natural rubber after centrifuged. The result is shown 4 layers including

1. The rubber layer
2. Frey Wyssling layer
3. The C-serum layer
4. The lutoid layer (the bottom fraction)

The rubber layers are about the rubber particle, protein, and phospholipid that shown in figure 2.6. The rubber particle appearance is quite round. The size of the rubber particle varies between 0.04 - 4 microns. Most rubber particles are larger than 0.4 microns. The average particle size of mature rubber trees was about 1 micron. When the latex is centrifuged, large rubber particles are separated from the water layer. **[1]**

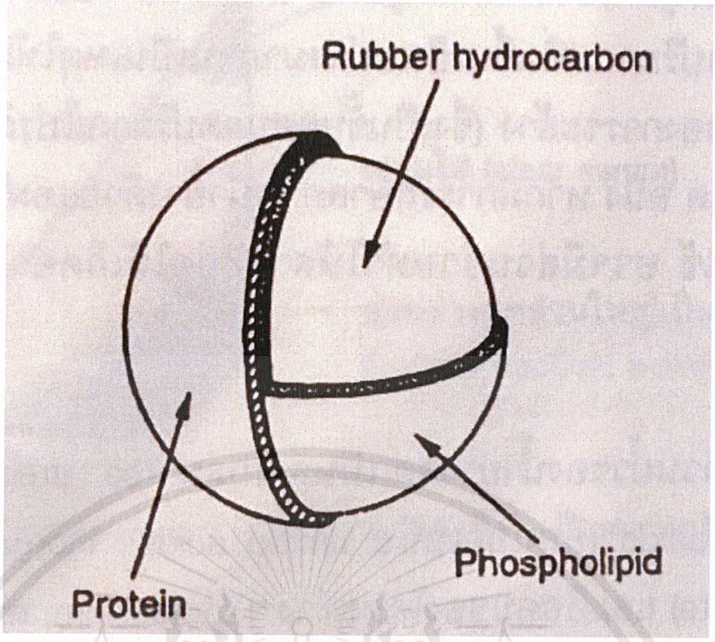

Figure 2.6 The rubber particle appearance **[8]**

In the part of Frey Wyssling layer, the Frey Wyssling layer is the non-rubber particle that is larger than the rubber particle but lower in density. The shape of Frey Wyssling particles is quite round and the walls are surrounded by two floors. The Frey Wyssling was containing the carotenoid pigment to make the rubber in dark-yellow color. In the part of C-serum layer, the C-serum layer was containing with carbohydrates, proteins and amino acids. In the bottom layer, the lutoid is a round particle that encapsulated with thin-membrane. Inside the membrane, there are both solutions (soluble protein and insoluble protein) with pH 5.5. Moreover, the diameter of lutoid particle is between 0.5 – 3 microns. **[1]**

2.2 The preservatives chemical of natural rubber latex.

The preservatives chemical of natural rubber latex is the substance that put into the natural rubber latex to keep the condition in natural rubber latex and prevent the coagulation in natural rubber latex. The Alkali substances must be applied to prevent the coagulation of natural rubber latex, the growth of bacteria and to allow the charge on the rubber particles for becoming more negative that make the natural rubber latex more stable. In this research, we use sodium hydroxide as alkali solution. On the other hand, acid solution was added into the natural rubber latex to make the natural rubber coagulated quickly. In this research, we use hydrochloric acid as acid solution.

2.3 Spray drying

2.3.1 Definition

Spray drying is by definition the transformation of substance from a fluid state into a dried powder form by spraying the feed into a hot drying medium. It is a one-step, continuous particle-processing operation involving drying. The feed can either be a solution, suspension or paste. The resulting dried product conforms to powders, granules or agglomerates, the form of which depends upon the physical and chemical properties of the feed and the dryer design and operation. Spray drying is a procedure which in many industries meets dried product specifications most desirable for subsequent processing or direct consumer usage. Intensive research and development during the last two decade has resulted in spray drying becoming a highly competitive means of drying a wide variety of products. [10] The range of product applications continues to expand, so that today spray drying has connections with many things we use daily. The extent of this is worth summarizing as part of the introduction. [11]

The operation of the Spray Dryer, starting from the air is flowed through the filter and passed through the heater. Then the air is entered to the drying chamber. The liquid is flowed by the pump through the device that causes the droplets, namely the atomizer. When the aerosol is exposed to hot air, it causes rapid evaporation of water and powder products will fall to the bottom of the drying chamber. Some powders that come out with the air will be separated by using cyclone, which will eventually be integrated into the final product.[12]

Figure 2.7 the spray dryer reactor

2.3.2 Process stage in the spray drying

Spray drying consists of four process stages.

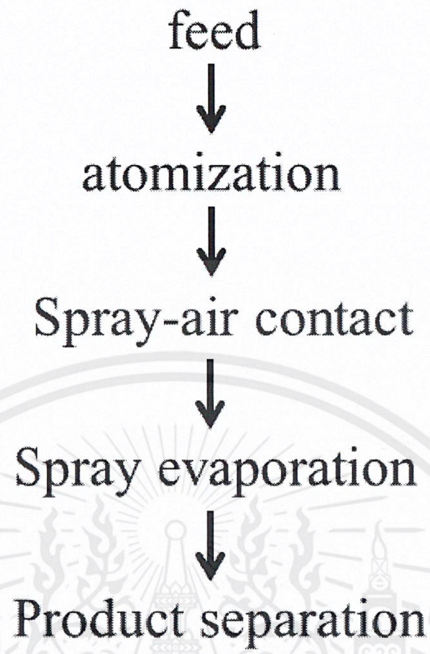

Figure 2.8 The diagram of the process stages in spray drying

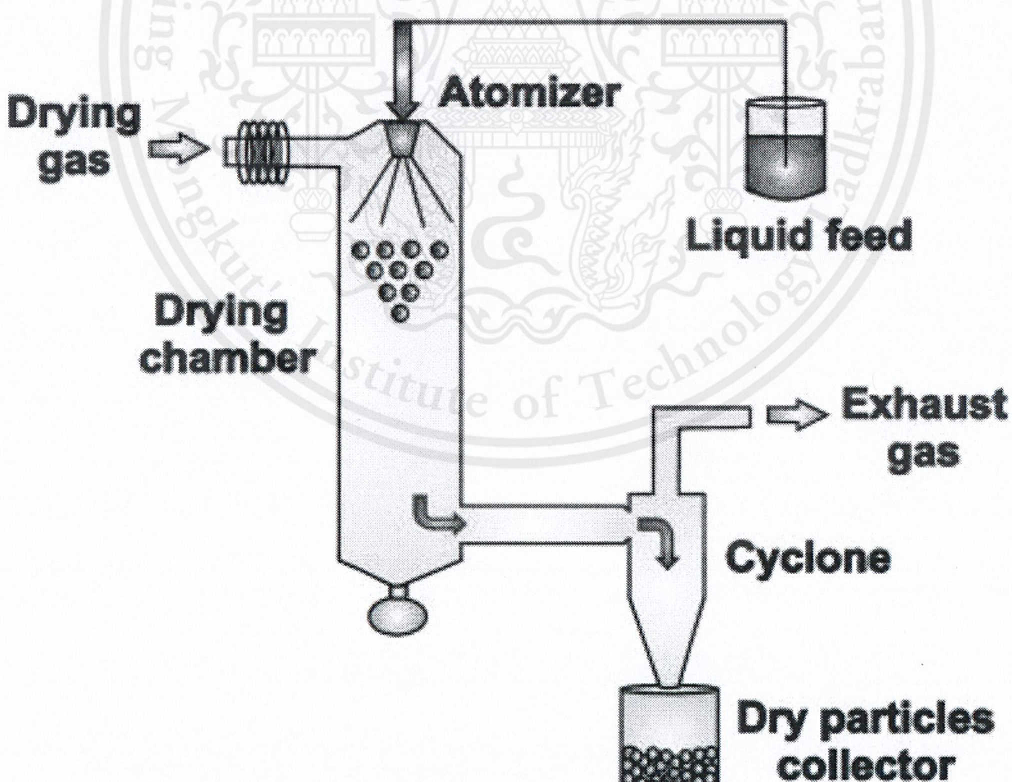

Figure 2.9 The spray-drying process [13]

The spray-drying process consists of four process steps:

1. atomization of feed into the spray
2. mixing and flow (spray-air contact)
3. moisture evaporation and
4. separation of dry product

Figure 2.9 shows a scheme of the conventional spray drying process. First, the fluid is fed into the drying chamber by a peristaltic pump through an atomizer or nozzle that can be a rotary atomizer, a pressure nozzle or a two fluid nozzle and the atomization occurs by centrifugal, pressure or kinetic energy, respectively. The small droplets generated (micrometer scale) are subjected to fast solvent evaporation leading to the formation of dry particles that are separated from the drying gas by means of a cyclone or bag filter that deposes them in a glass collector situated in the bottom of the device.[13]

The fluid feeds in spray-drying can be solutions, suspensions, emulsions, slurries, pastes or melts Solid products obtained after the process have the advantage of higher chemical and physical stability compared to liquid formulations. In addition, they can be used as precursors for the production of other suitable dosage forms such as capsules or tablets. [10]

2.3.3 Advantage of spray drying

1) Continuous in operation
2) Adaptable to full automatic control
3) Dried product specifications met through dryer design and operational flexibility.

2.4 Literature review

From relevant research, it was mentioned about the method to prepare the powder natural rubber. K. Saowanee was written "Natural rubber production" in the book, it writes about preparation the powder natural rubber from natural rubber or dry rubber

a) Using natural rubber latex

Powder rubber can be prepared by applying concentrated cream latex spraying into hot room at 93°C. The hot air and anti-stick substance (Which could be ultra-fine silica powder VN3 or zinc stearate) were blowing into the room. The water in the rubber was evaporated; the rubber particles would fall to the floor or stick to the wall.

b) Using dry rubber

Drying of powder rubber could be as follows.

1. The rubber is cut into small pieces with the granulation reactor.
2. Decrease the temperature of rubber to transition temperature by using liquid nitrogen to provide solid frame. Then, grind the rubber to powder.
3. Make the rubber in powder rubber form by grinding through the roller. [1]

J. Tippapong and et al. was study about “Yield optimization of spray-dried natural rubber and properties of Its silica-filled composite” that the preparation of natural rubber powder (NBP) was used the spray drying method and optimized via statistical experimental design. The yield of NRP obtained significantly depended on the percentage of dry rubber content (DRC) and the amount of sodium dodecyl sulfate (SDS). The research was operating under the condition: an inlet air temperature of 130◦C, a feed rate of 4 mLmin−1 and 15%DRC. Under these conditions, a NRP yield of 44.9%, and a total solid recovery of 98.7% with a moisture content of 0.4% was obtained. Thee characteristic of powder rubber was almost spherical with a diameter of less than 10 μm. The mechanical properties of NRP, in terms of the modulus, tensile strength, and hardness were greater than that for conventional block rubber. [14] To give the inlet air temperature of 130◦C could use with the process that would not affect the properties of natural rubber.

Lucilene Betega de Paiv and et al. was study about "Preparation and properties of rubber powder from modified-SBR latex by spray drying process" Styrene-Butadiene Powder Rubber was prepared by add Methyl methacrylate and colloidal silica in the rubber. Then, it was passing through the spray dying process. Under the condition: an inlet air temperature of 120°C, an outlet air temperature of 75- 80℃ and a feed rate of 4.16 mLmin−1 or 250 mLhour-1with a Mini Spray B-190 from Buchi Labortechnik AG. The result from the experiment gives the spherical powder rubber. It has the diameter between 1 micrometer – 10 micrometer.[15]

J. D. Wang and et al. was study about "Preparation and Mechanical Properties of Natural Rubber Powder Modified by Carbon Nanotubes". Prepare natural rubber powder modified by add carbon nanotube in the natural rubber latex and bring the liquid to spray drying by means of Buchi B290 Mini Spray Dryer (Bu¨ chi Com., Switzerland), The preparing process and the powder sizes were controlled by modification of the working conditions of the spray drying processes. The optimized parameters of the spray drying processes are under the condition: the liquid entering temperature, 180°C; the liquid flowing rate, 15% or 4 mLmin-1; and the inspiriting rate = 100%. It is suggested that the liquid entering temperature should be 120°C if the rubber powders would be used to produce vulcanized rubber products. Then, NR powders modified by CNTs were produced. The composite powders were round-like and fine, with an average diameter of less than about 5 micrometer.[16]

CHAPTER III
RESEARCH METHODOLOGY

3.1 Materials and Chemicals

1) Natural rubber latex
2) Sodium hydroxide (NaOH) 2 M
3) Sodium Lauryl ether sulfate (Texapon N70)

3.2 Equipment and Apparatus

1) Beaker
2) Syringe
3) Rubber gloves
4) Glass Bottles
5) Cover
6) Glass plates
7) Label
8) Stirring rod
9) Spray dryer
10) Scanning electron microscope (SEM)

3.3 Procedure

3.3.1 Preparation the condition of fresh natural rubber latex

1) Add NaOH 2 M and natural rubber latex into the beaker (ratio additive: natural rubber = 1: 10) and stirred together.
2) Keep the prepared natural rubber in the closed system.

3.3.2 Steps to determine the diameter size of rubber particle.

1) Perform preliminary experiments to find the value of inlet hot air temperature and simple feed rate for design the value in the real experiment.
2) Take N70 to dissolved in deionized water. Stir the mixture for 10 minutes until the solution is clear.
3) Take the solution mix with natural rubber. Stir the mixture for 10 minutes.
4) Take the latex to sprayed under condition: the inlet temperature = 130℃ , a feed rate of 4 mLmin-1

sample	1	2	3	4
Nozzle flow rate (liter/hour.)	200	300	400	300 with N70

5) Collect the sample, studying the morphology of powder rubber using scanning electron microscope and the effect of nozzle flow rate with the diameter size of powder rubber particles.

CHAPTER IV
RESULTS AND DISCUSSION

This chapter describes the studies of the production of powder natural rubber using spray drying method and the steps were given in Chapter 3. The study variable is the nozzle flow rate. The controlled variables are inlet air temperature, a feed rate, % dry rubber content and 12 parts per hundred of rubber (phase) of N70.

4.1 Physical properties of powder rubber

Figure 4.1 Photo of powder rubber prepared by spray drying method

Figure 4.1 show powder rubbers obtained from the spray dryer. The powder rubber was a fine white powder, round shape and light weight.

4.2 Study of the morphology of powder rubber

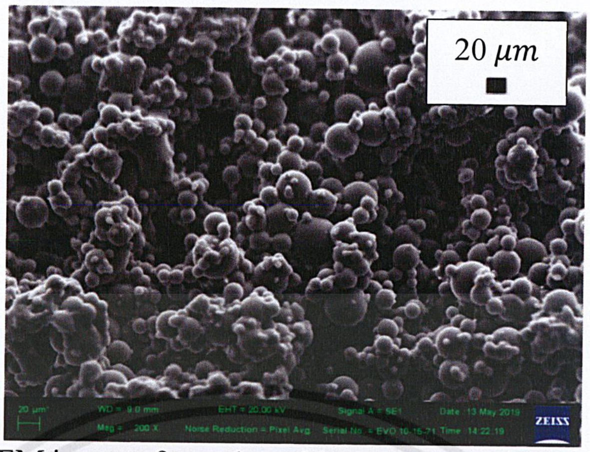

Figure 4.2A) SEM image of powder rubber at nozzle flow rate 200 liter/hour

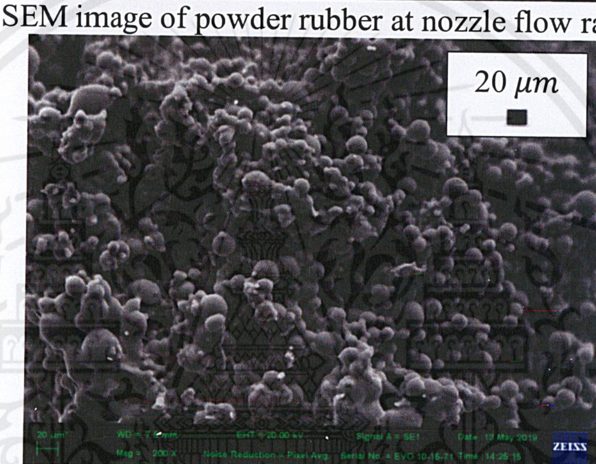

Figure 4.2B) SEM image of powder rubber at nozzle flow rate 300 liter/hour

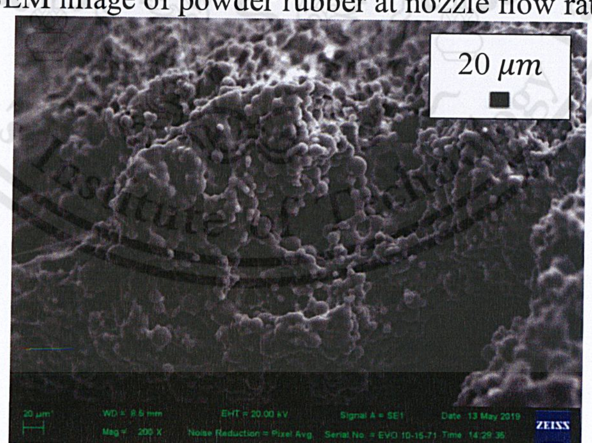

Figure 4.2C) SEM image of powder rubber at nozzle flow rate 200 liter/hour

Figure 4.2 SEM image of powder rubber at nozzle flow rate
A) 200 liter/hr. B) 300 liter/hr. C) 400 liter/hr.

Figure 4.2 shows the results of powder rubber at nozzle flow rate at 200, 300 and 400 liter per hour that operate under condition: the inlet air temperature = 130°C , a feed rate = 4 ml/min, %dry rubber content = 15. The characteristics of powder rubber were a round shape. At the nozzle flow rate of 200 liters per hour, the diameter of the powder rubber was approximately 33 micrometers. At the nozzle flow rate of 300 liters per hour, the diameter of the powder rubber was approximately 23 micrometers and at the nozzle flow rate of 400 liters per hour, the diameter of the powder rubber was approximately 10 micrometers. The results can be observed that when increasing the nozzle flow rate affecting the diameter of the powder rubber to decrease.

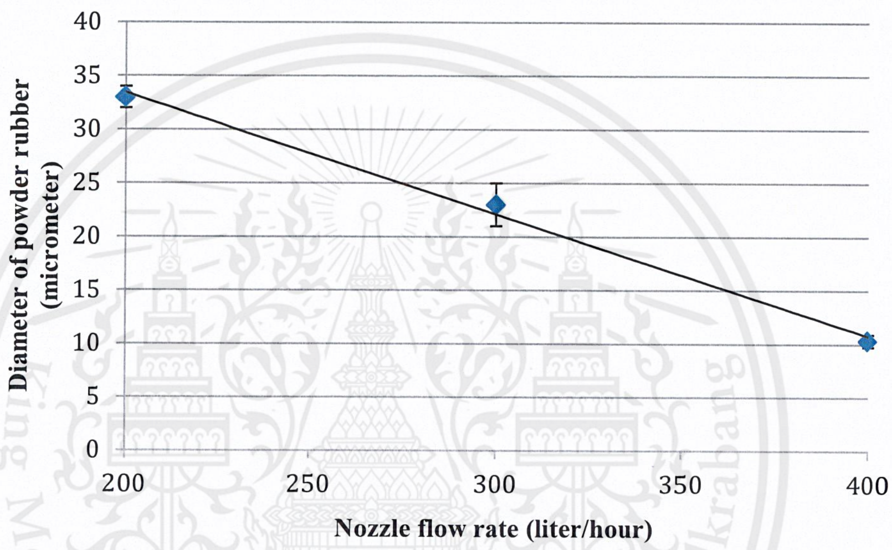

Figure 4.3 Graph plotted between nozzle flow rate and diameter of powder

These results, increasing the nozzle flow rate would have an inverse effect on the diameter of the powder rubber because when the nozzle flow rate increase resulting with the droplets of NRL. The compression of the air through the nozzle to the drying chamber makes NRL more delicate. Causing the rubber from evaporation to be smaller.

4.3 Effect of the nozzle flow rate on yield.

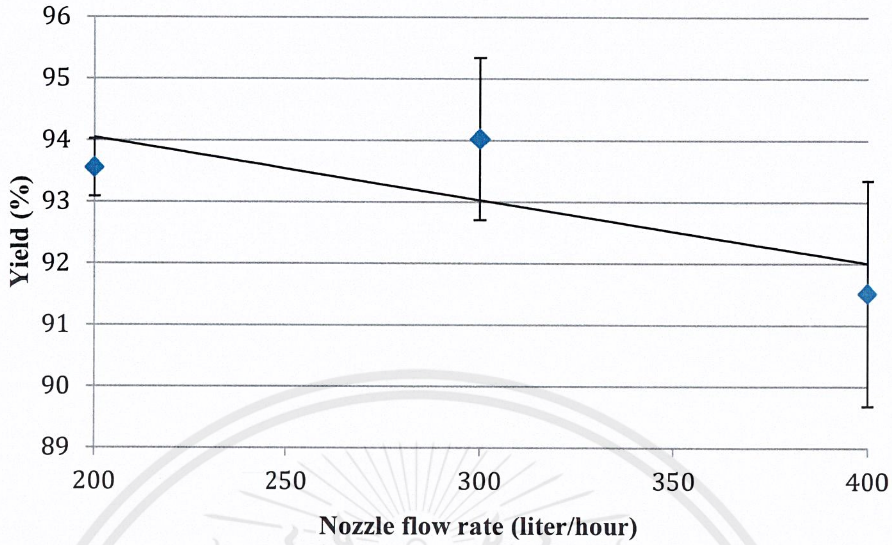

Figure 4.4 Graph plotted between yield (%) and nozzle flow rate

From Figure 4.4, it found that at the inlet air temperature = 130°C, a feed rate = 4 mLmin-1, %dry rubber content = 15. When the nozzle flow rate is 200 liter/hour resulting in a percent yield = 93.56, when the nozzle flow rate is 300 liter/hour resulting in a percent yield = 94.02 and when the nozzle flow rate is 400 liter/hour resulting in a percent yield = 91.52. From the data, it was concluded that when increase nozzle flow rate, the percent yield of powder rubber was decreased. Because the increasing of the nozzle flow rate makes the powder rubber leaving from the nozzle to wider distribution. From the results, it was found at the nozzle flow rate of 300 liter/hr. would provide the highest yield.

4.4 Study of the morphology of powder rubber with N70

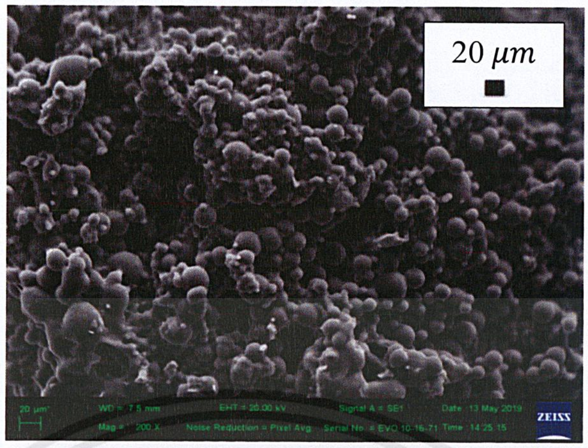

Figure 4.5 SEM image of powder rubber at nozzle flow rate 300 liter/hr. without N70

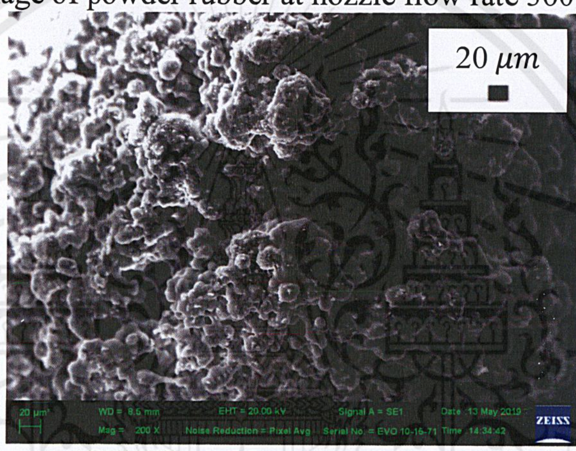

Figure 4.6 SEM image of powder rubber at nozzle flow rate 300 liter/hr. with N70

From the figure shows the powder rubber produced at the inlet temperature 130°C, a feed rate of 4 mL min^{-1} and the nozzle flow rate is 300 liter/hr. because the high yield was produced in this condition from the result in the primary experiment. The natural rubber latex used in this experiment has 15 %dry rubber content. From the results, it could compare that the diameter of powder rubber without N70 is 23 micrometer and the diameter of powder rubber with Texapon (N70) is 10 micrometer. The powder rubber without N70 has a round shape and the powder rubber with N70 has a rather round shape, connecting surface, it did not separate the grain clearly as the powder rubber without N70.

4.5 Effect of yield on phase of N70

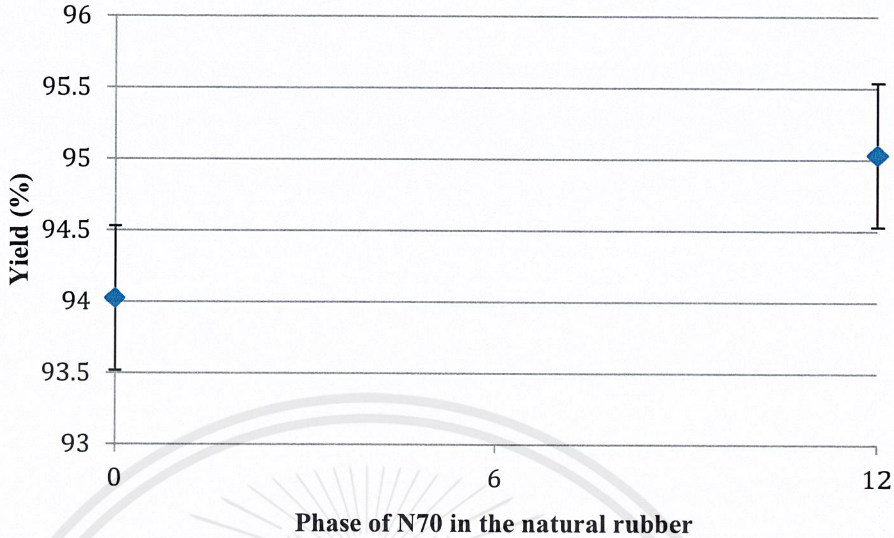

Figure 4.7 Graph plotted between phrase of N70 and percent yield (%)

From Figure 4.7, when using the nozzle flow rate that gives the highest value of percent yield to compare the results between natural rubber latex with N70 and without N70. It can found that the natural rubber latex without N70 gives the percent yield is 94.02 % and natural rubber latex with N70 gives the percent yield is 95.02%. From the result, it was conclude that natural rubber latex with N70 provides the higher yield.

CHAPTER V
CONCLUSION

5.1 Conclusion

This research aims to determine the distribution of particle size diameter of the powder rubber from fresh natural rubber latex with spray drying method. The study variable is the nozzle flow rate. The controlled variables are inlet air temperature, a feed rate, %dry rubber content and parts per hundred of rubber (phrase) of N70. From the results of the experiment, it was found that the nozzle flow rate had an effect with the diameter of powder rubber and the percent yield. The condition used in the experiment is the inlet temperature 130°C, a feed rate of 4 $mLmin^{-1}$ and percent dry rubber content = 15.

The results can be observed that

1) When increasing the nozzle flow rate affecting the diameter of the powder rubber to decrease

2) When increase nozzle flow rate, the percent yield of powder rubber was decreased due to the high value of nozzle flow rate makes the powder rubber leaving from the nozzle, it would be wider distribution of the capillary latex effect to the percent yield of powder rubber.

From the result, the best value of nozzle flow rate is 300 liter/hr. it gives the highest percent yield and the appropriate size of the powder rubber.

For study of the morphology of powder rubber with N70 to test natural rubber latex with N70 could prevent the aggregation in the powder rubber. The powder rubber produced at the inlet temperature 130°C a feed rate of 4 mL min-1, 15% dry rubber content and the nozzle flow rate is 300 liter / hr. because the highest percent yield and the appropriate size of the powder rubber was produced in this condition. From the results, the powder rubber has a round shape and the powder rubber with N70 has a rather round shape, connecting surface, it did not separate the grain clearly as the powder rubber without N70. It could be concluded that the natural rubber latex with N70 affecting with the aggregation in the powder rubber. The natural rubber latex with N70 would make more the aggregation in the powder rubber.

5.2 Suggestions

1. From the result, the powder rubber was still being held together even though its contain substance that prevent the aggregation in the powder rubber. It should find appropriate substances and amount prevent the aggregation of powdered rubber.
2. After each experiment, the reactor should be removed and washed to minimize error in the results.
3. From the results of the experiment, it should find additional ways to be able to increase the amount of yield

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Appendix A
Pictures of the Experiment

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Pictures of the Experiment

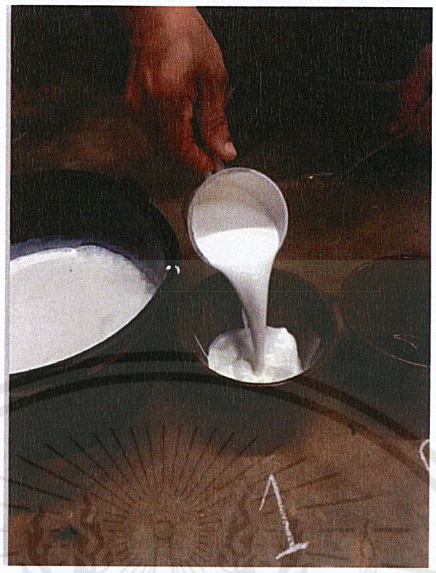

Figure A1 Find the amount of time that natural rubber latex was coagulated.

Figure A2 Find concentrations of sodium hydroxide were preventing the coagulated in the natural rubber.

Figure A3 2 M. NaOH gives the best results to preventing the coagulation in the natural rubber.

Figure A4 Add the sodium hydroxide immediately gives the best result to prevent the coagulation of natural rubber.

Figure A5 Layer of natural latex after centrifugation at high speed (11,000 rpm)

Appendix B
CALCULATION

Appendix B

CALCULATION

- **Calculation of % dry rubber content**

In the experiment, the natural rubber latex obtained from the rubber tree was measured %dry rubber content to obtain the desired dry rubber content by using the calculation formula

$$N1V1 = N2V2$$

When N1 is % the initial value of dry rubber content.

V1 is the weight of the initial natural rubber latex.

N2 is the desired value of dry rubber latex.

V2 is the initial weight of the natural rubber latex with the weight of the water added.

- **Calculation the percent yield of powder rubber**

The percentage of powder rubber can be calculated from the formula.

$$Y = (W2/W1) X 100$$

When Y = Percent yields of powder rubber

W1 = weight of Dry rubber in natural rubber latex

W2 = weight of powder rubber collected from the spray dryer

- **Calculation the amount of N70**

N70 (Texapon, Sodium Lauryl Ether Sulfate) is a surfactant used to mix with natural rubber latex before spray drying to make it easy to spray because it will prevent the aggregation in the powder rubber.

The amount of N70 used in research is 12 phr.

Therefore, if using the rubber 100 g. it must be mixed N70 12 g.

Natural latex 100 ml. dry rubber 14.95 g.

Therefore the amount of rubber 14.95 g. it must be mixed

N70 = (14.95X 12)/100 = 1.794 g.

- **Calculation the total percent yield of powder rubber**

In the experimental, it has dry rubber products in the container 8.3177 g., in the drying chamber 7.3497 g. and in the cyclone 0.4754 g. It has all dry rubber (powder rubber) 16.1428 g. but in the experiment, N70 was added to 1.794 g. Therefore, the total amount of powder rubber was calculated from

Total amount of dry rubber) = rubber at container + drying chamber + cyclone) – N70

= (8.3177 + 7.3497 + 0.4754) – 1.794

But the dry rubber that calculated from natural rubber latex is 14.95 g.

Therefore, the total amount of dry rubber is equal to (14.3488/14.95)*100 = 95 %

BIBLIOGRAHPY

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