

**ANALYSIS OF ENVIRONMENTAL THREATS
DURING RUBBER PROCESSING IN GHANA ;
(CASE STUDY OF GHANA RUBBER ESTATE LIMITED)**

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<p>Abstract:</p> <p>The main objective of this dissertation was to analysis, reduce and control the environmental problems occurs during rubber processes at Ghana Rubber Estate Limited. The work was carried out with both Qualitative and Quantitative Research. The problem of the thesis was a truly generic and unique problem. The processing and production of the company makes the problem generic and unique in the country. The problem had effects on the ecosystem and human as well.</p> <p>The qualitative analysis of the thesis was done by interviews, discussion and observations. The information gathered, justify the environmental condition of the district. The quantitative research based on data retrieved from the health centers and the questionnaires distributed to know the general opinions of Ghana Rubber Estate Limited Workers and Ahanta West District. This dissertation outlined the toxic chemicals used in Natural Rubber Processing and the control of such chemicals.</p> <p>The thesis analysis the environmental threats during rubber processing as follows; Water pollution- The activities of Coagulation and Equipment Maintenances Land Pollution- Through Rubber Tapping and Packaging Air Pollution- Diseases and Pest Control.</p> <p>The Result of the work found out that the environment is polluted during an increase of rubber production in the area due to the suddenly decreased of air bone and respiratory diseases when the company production decreased.</p>	
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1 CHAPTER 1- INTRODUCTION

1.1 Background

In this millennium the use of rubber has become versatile and it has been increase in volume sales in the Engineering firms either the manufacturing or production sectors as well as Business industries. This has result in expansion and increase in numbers of Plastics and Rubber manufacturing companies and factories in World. The idea of Plastics or Rubber invention is moving at faster rate than metallurgy and paper Technology and it is gradually diminishing usage of metallic product and also serving as a substitute and alternatives as the use of paper products. The availability of rubber raw material is rating good as compare that of metals. These factors are encouraging individuals or people to patronize in rubber production activities.

There are about six varieties of natural rubber. The species depends on the ecological factors of the area for growth. The varieties are as follows:

- *Para Rubber Tree*
- *Gutta Percha*
- *Rubber fig*
- *Panama Rubber Tree*
- *Common Dandelion*
- *Hevea brasiliensis*

The *Hevea brasiliensis* is a type of rubber tree produced for commercial purposes and well known in the Natural Rubber Industry.

The natural rubber tree, which is scientifically called *Hevea brasiliensis*, cannot produce any finite engineering material without undergoing processing. The processing of the rubber will passes through some production phases and stages. The Production processes will have impact on the environment.

It was mentioned that currently the usage of rubber products are widely increasing therefore the environments will definitely be affected by processing and manufacturing.

The environment impacts during rubber processing can have positive or negative effects on the society or the environment. The environment is a boundary or kingdom in which all living organism and non-living organism performs its functions. Therefore each and every one must be concerned about the environment. This concern has been the reasonable or the ultimate goals for organizations, associations, government bodies and Individuals willing to donate or spend a huge sum of monies or funds on environmental protection awareness. In a way of organizing conferences, seminars, exhibitions and meeting up to pass environmental policies and laws.

The United National Environmental Assembly, which was formerly called United Nations Environmental Program (UNEP), is campaigning especially in Africa continent and educating the people in a way individual can be equipped with ongoing environmental challenges which the world is battling or facing.

The United Nations Environmental Assembly are extending their resources and dealing with Africa environmental issues more vigorously in a way the rapid change of climate at the continent will be reduced. In this way the United Nations Environmental Assembly is aiming to achieve the goal of the world being environmentally friendly. Moreover the environment needs to be protected to ensure good sustainability of green economy. That is why the UNEP has decided to choose 5th of June as Environmental Day and also called the Earth day.

In other way, I am well pleased about their effort and the good work the Organization is doing and this has facilitated me to extend my knowledge which I have achieved through the studying of Plastics technology Program to help my community (Agona – Ahanta District) in Ghana which is suffering from environmental exchanges caused by Ghana Rubber Estate limited during Rubber Processing and also I thought of choosing that topic as my degree dissertation because with much research and analysis I hope it will be beneficial to folks of the districts, the company and the entire nation as a whole. [1]

1.2 Problems

The fundamental hindrance at Ghana Rubber Estate Limited during operation is environmental threats. This has been the major problem the company and the communities are facing since the establishment of the Company and also when they started processing the rubber. Environmental pollution is an agent of ecological resilience which serve has environmental threats during rubber processing.

The main research questions concerning this thesis are as follows:

- What way does the rubber crumbs affects the land?
- What procedure can farmers use to harvest the rubber to eliminate mishandling of the raw materials?
- How do the toxic chemicals and the rubber waste pollute the environment during rubber processing and its effects on the environment?

1.3 Aims and Objectives

The aims and objective of this thesis is classified into three categories; the education, cost minimization and Environmental friendly Objectives. The main ideas of this aims are as follows:

- To prevents lands destruction and water pollution when processing rubber.
- Reduction of toxic chemical exposed into the atmosphere.
- To Educates workers to optimized the company profit by minimizing the mishandling of latex through harvesting.

1.4 Literature Sources

The information gathered during the dissertation was done on the following way:

- Literature review

It is very necessary to organized or sorts out information on particular topic, before you commence to write a thesis. This was done by reading books, articles, journals and other scientific publications. This helped to retrieve the core background information for the thesis work and serves as foundation of the dissertation.

- Case studies

The Ahanta West District folks and Ghana Rubber Estate workers was set as the case study group. The case studies was used to describe the target group of individual which the work is associates. It helped to get some analysis of the problem. The rubber processing is been processed in the factory and districts mentioned.

- Health Archival Data Retrieving

The record of patience information on environmental diseases in the various health centers was retrieved. from their database for comparing the increase of environmental diseases from the past five years. The information was gathered at four health centers established in the districts. These hospitals are as follows:

Agona Nkwanta Health Center,

Nana Hema Dekyi Hospital,

Abura Clinic

Apowa Health Center.

The hospitals and the health centers mentioned above are the main hospitals in the district which communities or the voyagers visit.

- Observational Trial

There is a saying that '**seeing is believing**', it was very necessary for me to visit the premises of the company and the communities to get the primary data or get information

in terms of company operations and the consequences on the environmental or the harmful impacts on individual.

- Internet research

This helped to find other source of information from the internet or some secondary data from other rubber company web pages. It enabled the thesis work to have boundary or limitation of retrieving information and accelerate searching rate or period.

- Interviewing Professional

An experience and expert professionals like chemical engineers and Environmental Engineers. Their opinions seeking had a great impact on the work

- Systematic analysis and synthesis

The method was implemented to analyze the product by using the environmental assessment. It was done by glancing through several environmental books which has theoretical and methodological contributions

1.5 Limitations of the Studies

The most difficult areas which students or authors encounter are gathering information from other companies or society to write their thesis. Apparently as compare with Africa and Europe, it is difficult to retrieve information from Africa companies as other authors complained. In my situation, I did not find it easy as well when gathering the information, because the line of the thesis was mainly centered on a company called Ghana Rubber Estate Limited (G.R.E.L) and since I was a shareholder in the company, so the workers was little nervous to deliver information to me. They had a fear that am go-

ing to base on the information gathering to cut off their work force which will have effects on their salary.

Furthermore there were some inconveniences that occurred during the interviewing and gathering the data at hospitals since I have lived in the district for couple of years and am familiar with them. The health workers were not willing to provide me the information of the patience, therefore I have to employ other students at high school to distribute the questionnaire for me at my home town and take care of the nearby town am not known to them. Due to these circumstances the scope of the thesis was mainly emphasized on natural rubber processing at G.R.E.L and how to find better way to prevent the environmental threats which was causing problems between the company and the Ahanta West District.

2 LITERATURE REVIEW

Chapter 2 -COMPANY PROFILE

2.1 Company Presentation (Ghana Rubber Estate Limited)

Ghana Rubber Estate Limited (G.R.E.L), the company was initially a private sector business owned by R.T Briscoe in 1957. It was covering a plantation area size of 923 hectares at Dixcove in the Western Region of Ghana. In the year 1960 , the Rubber Plantation business attracted the interest of the Country, Ghana . The country developed a keen interest and it was nationalized at that year, the company was managed by Agriculture Development Corporation (ADC) and later State farms Corporation in 1962 where the total land area of plantation has yield to 36390 hectares at Abura, Dixcove and Subri all in Western Region of Ghana. The Ghana government signed a venture with a United State of America Company called Fire Stone Tire, company in 1967. The

Joint Venture Company was Ghana Rubber Estate Limited (GREL). Ghana Suffered from serious hunger draught and political power shared and economic crisis, during 1979 -1982 so the Fire stone sold it shares in GREL to Ghana Government in 1980. Therefore the Ghana Government owned about 95 percent by the state in 1980, which the total area of plantation size was 39,390 hectares.

After the Firestone sold it shares to the Ghana Government, GREL enter a financial agreement with Agence Francaise de Development, a French company. The main idea or purpose of the financial agreement between these companies to promote sustainability development in the company by given the ultimate power to Agence Francaise de Development to manage and rehabilitate the rubber plantation, to build a mega rubber processing plant and factory for GREL at Apimenim .

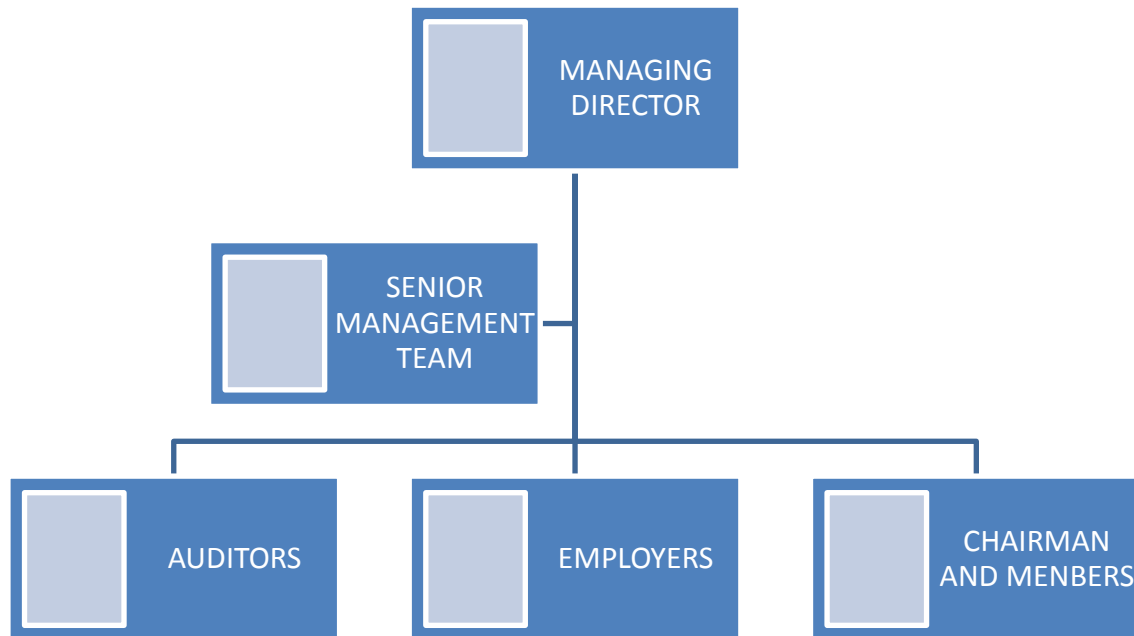
Currently, the SIPH Company holds the major shares in Ghana Rubber Estate Limited. They are a French management who are managing the business affairs of the Company [2]

2.2 Organizational Chart for GREL

The Managing Director, Mr Lionel Barre, he is responsible for about 70percent decisions making concerning the management of the company, the managing director plays major role in the company. He is responsible for any drawback about the company development.

The diagram below shows organizational Chart of Ghana Rubber Estate Limited

ORGANIZATION CHART FOR G.R.E.L



The figure (1) drawn by the Author.

The Senior Management Team comprises:

- Estate Manager
- Financial Controller
- Project Manager
- Information System and Quality Manager
- Rubber out-growers Plantation Project Manager,
- Corporate Affairs Manager,
- Sales Manager
- Mature Farms coordinator
- Project Engineer
- Financial Manager
- Factory Manager
- Progress Animation Manager

- Rubber out-growers Project Accountant
- Deputy Rubber out-growers Project Manager

There is one renounce and competent accounting firms which is called Deliotte and Touché LLP. They are US Company which takes care of financial report, assurance and auditing work as well as financial advice for Ghana Rubber Estate Company.

The company cannot be run without the work of the rubber tapper, the factory men, the administrators and technical operators. The contribution of these workers makes the company function and they fall under the employers section on the chart.

The government of Ghana plays a role as a member in the company, Societe International De Plantation d'Heveas (SIPH) they are rubber and oil processing company in France. They have a representative as a member in the company, since they hold the major shares in Ghana Rubber Estate Limited and The chairman of the company is Jean Louis Billion who is from SIFCA Company. SIFCA they are the leading Africa agribusiness company who are into cultivation and processing of natural rubber, sugar cane and vegetable oil.[3]

2.3 The Company Statistics

Table 1: FACTS AND FIGURES OF GREL

Table 1a. PLANTATION

Total land of concession=	Total planted area =13010	Total surface area under
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15000 hectares	hectares	tapping =8532
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Table 1b. PROCESSING

Product: Rubber Crumbs	Capacity/Hour: 3min/ton	Power: 500MW
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Table 1c SALES MARKETING

EXPORT SALES: 96%	LOCAL SALES: 4%
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Table 1d DESTINATIONS OF EXPORT

<i>AFRICA</i>	<i>EUROPE</i>	<i>ASIA</i>	<i>America</i>
<i>Burkina Faso</i>	<i>Uk, Spain and Italy</i>	<i>Turkey</i>	<i>U.S.A</i>

Table 1e Total number of workers

<i>CASUAL</i>	<i>CONTRACTORS</i>	<i>DIRECTPAY</i>	<i>INTERNSHIPS</i>
		<i>ROLL</i>	

3000	1868	323	15
-------------	-------------	------------	-----------

Table 1 f. SOCIAL SERVICES

CLINICS	PRIMARY SCHOOLS	SETTELEMENTSC
1	2	2VILLAGE AND 2 TOWN

The tables starting from 1a to 1f represent the fact and statistics of the company.

Table 1A, 1B, 1C, 1D, 1E and 1F Source: (<http://www.grelgh.com/grel-facts>)

3 CHAPTER 3- GENERAL CONCEPT OF RUBBER

3.1 ORIGIN

Generally, Brazil is well known by their invention of natural rubber tree. This has brought a historical legacy or trade name to Southern American. It could be easily identify by the botanical name of nature rubber tree *Hevea brasiliensis*. The natural rubber was discovered in the year 1495-1496. The great man Christopher Columbus is not known by only discovery of America but also credibility is been accounted on him due his discovery of natural rubber tree. When reported he has seen American Indians playing with a bouncing ball which has been made of juice of trees. There was a law governing the discovery. This law was said that no sample of the rubber discovery should be sent to Europe continent for the next 240years. The French engineer Charles de le Condamine was the first person who studied rubber scientifically during his trip to Peru in 1735 , later Francis Fresnau concluded by his own findings and based on his home grounds that **`Rubber is nothing just condensed risenous of oil`** [4]

3.2 Definition of Rubber

According to international rubber study group, they defined rubber as a polymeric substance which contains carbon, oxygen, hydrogen and silicon of which falls under the property of elasticity. This mean it can be further processed by undergoing curing processed called vulcanization. Most vulcanized material has a strong mechanical property and they are less sticky [5.]

3.3 Types of Rubber

Rubber has been categorized into two types, The Natural Rubber (NR) and Synthetic rubber.

The Natural Rubber which is widely used by industrials is obtained by planting a rubber tree known as *Havea brasiliensis* to be matured for five to eight years so that it can be harvested. The process of harvesting is called tapping. This is done by coagulating the milky sticky substances called the latex from the bark of the rubber tree (*Hevea brasiliensis*).

3.4 Plantation of Natural Rubber

In Order to achieve a successful rubber plantation, the geographical area for plantation must be considered. The quality and quantity of the rubber are determined by the labor availability and a suitable good climate condition for the tree. The Natural Rubber Tree must not be grown at height of about 300 meters above the sea level. There is poor yield obtained when the plantation is above 300 meters. Although a research has been found that there is a plantation at Uganda which is above 1200 meters above sea level but that is not a good plantation due to poor output of the yield. The humidity and richness of the soil count the most essential condition for rubber plantation. The soil can get it full nutrient contents to support rubber cultivation or plantation successfully, if when there is an annual rainfall of between 1270 mm to 3810 mm at the region. This will count as evenly distribution of rainfall in the entire region and it will always maintain the soil humidity through the entire year. This mean during the dry season there will be little water at grounds to keep the soil moisture. Although the tree need water to grow but it is not good to plant rubber tree in a swampy ground. The scientist Wickham's proudly condemned the specimen of rubber raised near the river as the bad species. In addition swampy ground is detrimental to the plant. This is because most of the trees grown in a swampy area have a short tap roots and it only supported by it entirely lateral roots. This comes as result of tree leaning in all angles [6]

The Clearing of Land is the first procedure to be taken when establishing rubber plantation. When clearing the land there must be several measures must be taken. The soil nutrient must be consideration, the method of clearing and the type of mechanism empowered. In early days, the total surface area of land is completely cleared away before planting will take place. This kind of system is disadvantage to the growth of the rubber tree. If the total area is been cleared there will not be any undergrowth plants to support the well-being of the rubber trees. Currently there is minor weeding or clearing which are done and after that there will be burning taken place. The burning of the weeds adds nutrients to the soils as humus. This allows the top soil to be enriched in the nutrient level. In olden days there will be coffees planted between the rubber trees to give air spacing to the soil. This gives a room for competition of nutrient shearing between the rubber and the coffee. The planting of herbaceous creepers and shrubs has replaced the old systems and these cover crops or the leguminous plants provide nitrogen to the soil and turn into the soil interval for air circulation. This helps the soil to maintain its temperature. In a place of heavy rainfall, when the total area is cleared there will be no elements to check erosion. [6]

3.5 The Method of Planting Natural Rubber.

The difficult aspect of rubber cultivation is planting. It involves several technics and experienced. The natural rubber can be planted into two ways. The stake method of planting or the nursery planting method. The stake planting is method of where by the seeds are planted directly into the grounds after the clearing of the land or after preparation of the demarcated area of planting. In this method the seeds are allowed to grow from their original place of planting. In the nursery planting the seeds are nurse for some weeks and later removed from the nursery bed to be planted in the real farm. There are some prerequisite procedures involves in the nursery method. The seeds are planted into seedling bags. The seeds allow to germination in the bags. The germination of rubber seeds takes approximately one week. The nursery is kept for one year and the plants are removes to plants in the field of cultivation. This is called stump planting. In

order to remove the plants to the field the tap roots and the lateral roots needs to be trimmed. The method is expensive and much is time involved. It is appropriate in the drying season .it is an advantage way of prevent destructions of the seedlings from animals and other organism. In the tropical zones, rubber planting takes place in twice in a year. They have the minor seasons and the major season. The minor season, the planting takes place from September to October as well as major planting season take place at mid of may till at the end of June [6].

The amount of trees to be planted in the field matters much. The successful and good output of rubber yield is highly depends on the number of trees planted in the specific field. It is highly recommended that about 180 to 250 trees per acre (25600 square meters). This will result in quality and quantity latex. It is estimated that 10 acres of rubber plantation of five years old, there should be a yield of 1.5 to 2 tons of latex produces in a month. Furthermore there has been much advice and education regarding appropriate distances for planting. The Ghana Ministry of Food and Agriculture usually advice farmers to plants rubber trees of 200 to 250 trees per acre (about 25600square meter) matching a distance apart of about 5.2 meters. This gives better growth in girth. The maturity age of rubber trees for tapping is approximately four to seven years. It may accounts on the geographical area of cultivation and the kind of farm remedy. In order to cross examine the maturity of rubber tree, the girth size and the height are used. Wickham's concluded that a one year hevea tree should be about 20 cm girth and a height of 508mm after one year of plantation. They are considered for tapping when the girth is about 508 mm and the height of 1m. [7]

The figure (2) picture below shows natural rubber seedlings at nursery in Ghana Rubber Estate Limited.



Figure (2) Rubber Nursery at G.R.E.L

Source: <http://www.grelgh.com>

3.6 Natural Rubber Output (Yield)

In every plantation a high yield is a dream of a farmer. The yield of natural rubber is subjected to the soil. Since soil form the three dimensional component for which crops exploit their nutrient. The plants depend on the soil for nutrients and water. These factors are on certain conditions. A recent research (DVK Negeswara Rao ,2007; MD Jessy ,2007) which shows that soil volume has effective impact on the yield and growth of Rubber (*Hevea brasiliensis*). The Coarse fragrance in the soil increases the yield of the rubber latex. This occurs when the depth of the coarse fragrance in the soil is about 2mm. Therefore it is recommended that the soil surface which has less significant value of coarse fragrance must be applied much fertilizer for a high growth. In accordance with the explanation, the soil volume has a greatest impact on the latex output or yield of a natural rubber and also a studies carried out by (P.Sanjeeva Rao ,C.K Saraswathamma and M.,R Sethuraj, 1998) leading to relationship between yield and meteorological parameters of rubber tree(*Hevea brasiliensis*) shows that the weather condition has an effect on the yield of the latex during tapping. At times of a maximum temperature of 30.4 degree Celsius, intensive sunshine period, in appropriate significant value of the drying power of the air (vapour pressure deficit) and pan evaporation has negative impact of the yield. The result shows there is a positive input or yield obtained in the harvesting period at the raining season [8]

4 CHAPTER 4- NATURAL RUBBER COLLECTION

4.1 Hevea brasiliensis tapping

The Rubber Tapping is general term used to describe the harvesting of natural rubber. The process of tapping normally takes about twenty five seconds for an experienced tapper. Rubber tree can be tapped in active tapping from the age of fifteen to thirty years and inactive tapping from thirty to forty years and above. The economic life span for productivity is about twenty five years.

The Tapping is done by removing about one millimeter to two millimeter bark of rubber tree with a knife which has been slanted to cut through an angle from 20 ° to 30° the milky like fluid to flow into a cup mounted on each tree. The Fluid coming out after the cutting is called the latex. The latex is reserved into the latex cup. The cups are supported by a wire to hang the tree firmly. A good tapping helps or prolong the life of the tree. The tapping is normal carried out during hours of 4am to 7am. It is done early morning to avoid the sun. The sun rays are avoided because it slows the flow rate of the latex coming out from the tree. In addition during that period the internal pressure of the tree is at the highest level [9]

4.2 Methods of Tapping Natural Rubber (Hevea brasiliensis)

In Early days there were five tapping systems commonly used in commercial Rubber plantation. The tapping system can be identified in by the act in which the operation is done and the number of subsequence or the frequency of operation. The figure (3) be-

low clearly described the method each system is performed. The five methods of tapping are represented in alphabetical words.

- (A)- Full herring bone system;
- (B)-Half herring bone system,
- (C)- Half spiral system,
- (D)-Full spiral system and
- (E) -Single basal V system.

Tapping Systems

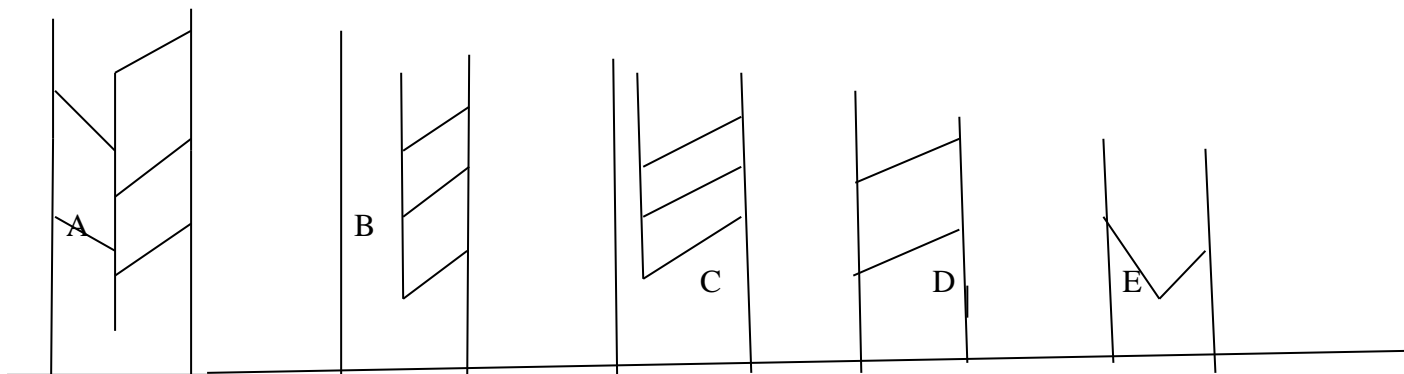


Figure (3) drawn by the Author shows tapping system of Natural Rubber. [6]

4.3 Coagulation of Natural Rubber (NR)

Coagulation is the stage at which the latex changes from the liquid stage to a solid stage. It normally happens by the mechanism of adding chemicals like formic acid and the latex sometimes coagulates naturally. In small rubber industry, they coagulum is processed in two methods. They exposed the coagulum to wooden smoke or by exposing it by drying air. The material will be now called Field Coagula. In Ghana the field coagula are classified into four types. They have the cup lump, the earth scraps, tree lace and the small holder lump. The tree lace is the coagulum lining sticky parts drawn at the previous cuts of the tree. The tapper peels of the tree lace before a new cut will begin. The

Cup lump, it can be easily identify the name. It is the material found in the latex cup or collection cup when the tapper visits the plantation in the next time for tapping. The purity of the material is graded the best among all the field coagula. The small holders lump is produce in the course of transporting the latex from the farm to the factory. It is organize by the smallholders who collect the latex dropping down during the transportation of the latex to the factory. They collect them into a bigger quantity and sell it to the rubber contractors. The earth scraps coagula is the latex found on the tree when there is excess of latex over flowing and it is can also be found on the tips necks of the tappers bucket used for collection. This may contains contaminated practices likes sand and leaves of other plants. It has a low quality rate as compare to the other coagula. [9]

4.4 Preventing Coagulation

The latex produced from the rubber contains protein membrane. The protein membrane is the feeding house for the bacteria in the latex. The bacteria have an effect on the rubber by producing an acid that will gives a room for the rubber to coagulate together. The recommended approach for preventing the latex from coagulating is introducing the neutralization mechanism. In this method the latex is poured into alkali solution. The introduction of alkali solution makes the negative charges produces by the rubber to remain without repulsing any forces or charges. It is preferable to use the alkali solution for example ammonia solution, because the hydroxide ions in the alkali solution neutralize the acid produce by the bacteria. [10]

4.5 Pathological Treatment of Natural Rubber

The Natural rubber (NR) tree is subjected to numerous pathological problems. The disease is mainly fungal origin. The pathological problem may occur at the early stage of the plantation. Its attacks the seedlings and budded plants in the nursery. In Ghana, leaf diseases which attacked the tree are *the South American Leaf Blight* and the *Corynespora Leaf Fall diseases*. The plants leaf turns to be yellowish throughout the entire raining period. When the leaves of rubber trees are observed in such situation then the plants are suffering from leaf disease. In addition, there are also serious diseases which attacked the tree after few years of plantation. The brown root disease (*Phellinus noxius*) and white root disease (*R.lignosus*). The roots and leaf diseases are usually found in a warm climate region. The controlling of the roots diseases can be done using fungicide curative approach system. This is done by clearing the land properly. In some parts of Africa especially in Ghana, the soil around the affected area of the roots is excavated and the affected disease portion of the roots is cut. They used pentachloronitrobenzene (PCNB) to spray the collar, tap root and the whole laterals of the tree. Immediately the spraying the soil excavated is replaced back to avoid other animal like grass cutters to destroy the roots entirely. The toxic aspect of PCNB so eight litres of water is used to dilute an amount of one liter PCNB to spray about one hectare of farm. The clones of the rubber trees which are affected by the *Rigidoporus lignosus* diseases can also be treated by *Calaxin^R* in manner of spraying all the clones. The two liters of *Calaxin^R* is used for two acre of plantation. In this approach, credit is awarded to Rubber Research Institute of Nigeria. According to their research carried out on the family of *Euphorbiaceae of laticiferous* plants. The most effective chemicals used to treat the diseases simultaneously are *Bayleton^R*, *Bayfidan^R*, *Folicur^R* and *Contaf^R*. The chemicals are used to drench the trunk parts of tree for every six months to avoid the loosening of soil around the roots. Another option is by applying sulphur into the planting hole. Sulphur fights against the spread of fungal infection to plants. The *Hevea brasiliensis* naturally produces antimicrobial phenolic compounds such as flavonoids and triterpenes. They have molecular weight and serves as a room for microbial infection. The pathogens infections will increase when the plant defense mechanism was damaged.

[11]

4.6 The Resistance of Herbivore and Pest in Natural Rubber

In Natural Rubber plantation, another limitation factor which can hinder the development of the plantation is herbivore attacks. Herbivore they are organism which feeds on herbs and they are dangerous to the growth of rubber plantation. They usually attack the leaves and which have effects on the photosynthesis cycle of the plant. Herbivore commonly attacks the natural rubber during the early stages. The glasscutters normally are animals which destroy the rubber plantation at the tropical region like Indonesia, Liberia and Ghana. The herbivore can be control by applying *Imidacloprid*^R which is toxic chemical around the tree. This imidacloprid treatment kills the grass cutters and it is not well recommended for the treatment. The Wild life Conservation Agency against the practice of killing animal like grass cutters and Squirrels. These animals although they are treats to plants growth but they are used for scientific research and also play important role in the ecological balance. They promote a good sustainability of forest reserves. The Ghana Ministry of Food and Agriculture, advice natural rubber farmers to use chromate copper arsenate and Bifenthrin^R to control grass cutter than using Imidacloprid^R to kill them. These chemicals are sprayed on the rubber. There is an unpleasant scent in the chemical which drives the grass cutter and other herbivores away. The rubber tree can be destroyed easily by pests such as aunts and termites. All these insect and pest can be control by termiticide treatment. The treatment of the termites and pests are very sensitive in this stage. In this stage the rubber trees are not well matured enough to resistance any harmful chemicals. Termiticide is a powdered chemical. The termiticides are applied are spread circular around each tree as well to prevent aunts and insect which fight against the plants. The chemical also prevent the pests which are generated from the soil and inner part of the earth. The breeding of insects comes as a result of cross pollination of flower plants in the farm. [12]

4.7 Cyanide Role in Natural Rubber Plantation

The tapping stage of natural rubber production involves breeding of pesticides and herbivores. In this stage the herbivores do not have much room to operate or destroy the plants. This is because the natural rubber plant produces compound called cyanogenic glucosides. The Cyanogenic glucoside releases a hydrogen cyanide. The cyanide can be found in the latex of natural rubber and cassava. Cyanide is a toxic compound which prevents herbivores during the tapping stage of rubber production. Any herbivores which attempt to feed on the rubber drainage .The cyanide in the latex kills the herbivore. The cyanide in cassava usually kills people in Africa due to the excessive fermentation of cassava dough for tippie meals like Banku and Akpale. The cassava is fermented for about two weeks and the acidic content rises. The process can attribute to headache and tight throat. The little amount of cyanide in food can result in human death .Organism have effects on extensive exposure of cyanide by suffering from to long time chronic diseases such [13]

4.8 -The Effect of Cyanide Potential on Natural Rubber

The research carried by (Lyd and Gray,1970), they explain that the cyanide potential can be calculate by the total amount of cyanogenic precursor such as diglucosidase and free cyanide accumulated per gram of a given tissue. The tissue can be found in the leaf, the inner bark and the seed of a *Hevea brasiliensis*. . The cyanide potential has a greater amount in the young leaf of *Hevea brasiliensis*. The cyanide potential content in the leaves of the *Hevea brasiliensis* can be reduced by sunlight exposure. The Cyanogenic glucoside contains a compound called Linamarin. It helps in the metabolism and germinating processes in natural rubber plant. The hydrolysis of a linamarin by the help of enzymes and linamarase result in the formation of glucose. The formation of glucose by

hydrolysis process by the enzymes can be decomposed into hydrogen cyanide and acetone. When the rubber tree is injured or tapped, the cyanogenic glycosides produce mixed with the beta glycosidases and it will be separated into carbohydrates product like sugar and the other part of aglycon. The chemical reactions during the hydrolysis processes that take place in the cyanogenic plants as indicated below.

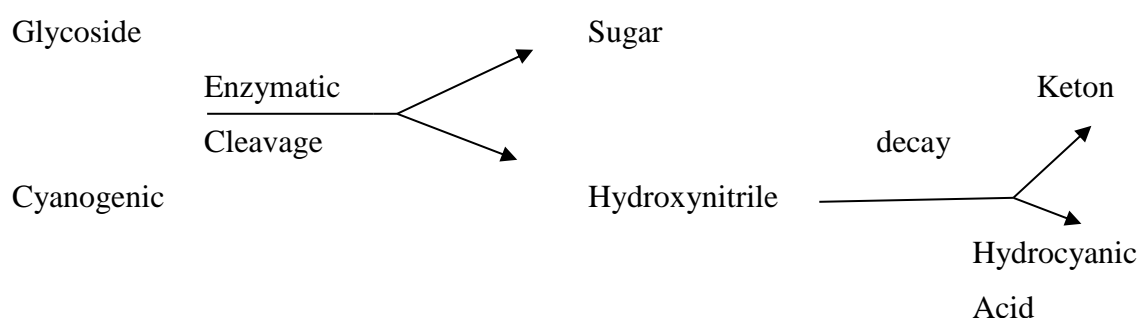


Fig (4) The hydrolysis process in Cyanogenic Plant

In recent studies carried on *Hevea brasiliensis* proving the involvement of cyanogenic glucose in rubber yield, it indicates that the cyanogenic glycoside act as a source of nitrogen or storage and carbon for latex generation in rubber production. The diagram shows the occurring of cyanogenic glucoside in rubber tree. [14, 15]

5 CHAPTER 5- NATURAL RUBBER PROCESSING AT GREL

5.1 The Processing Technology.

In Ghana Rubber Estate Limited the final product will be ready to export then the raw material has passes through several stages. There are two distinct technologies which

they used to process natural rubber. They normally used the Latex Technology method more often than the dry rubber technology processes. The Latex Technology has good physical properties than the dry rubber technology product; such as the colour and the formation of the bonds. The idea of choosing a specific technology may depend on the total quantity of latex collected in that period. There about twenty divisional point the latex is transported to the factory. They divisional points are called the Plumb Bank as known by the rubber carriers of the company.

5.2 The Natural Rubber Processing stages

There are four phases or stages which are used for the processing of the natural rubber at Ghana Rubber Estate Limited. The stages are the plantation phase, the factory phase and the logistics phase. The diagram below shows the various phases used during the rubber processing.

THE PROCESSING STAGES

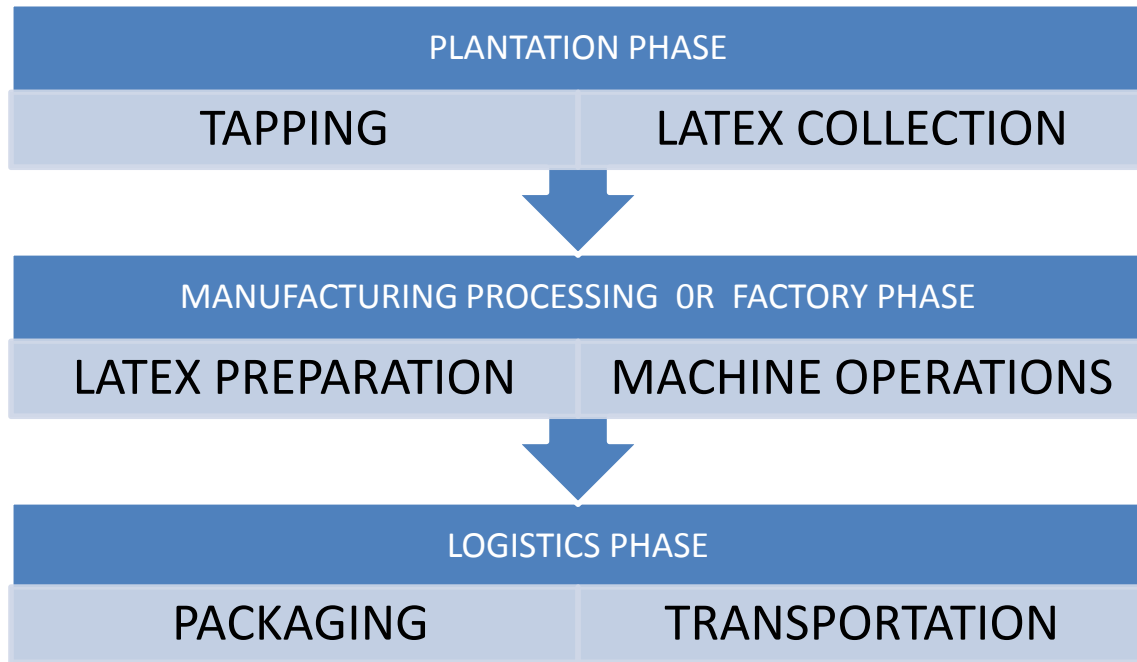


Figure (5) drawn by the Author

5.3 Plantation Phase

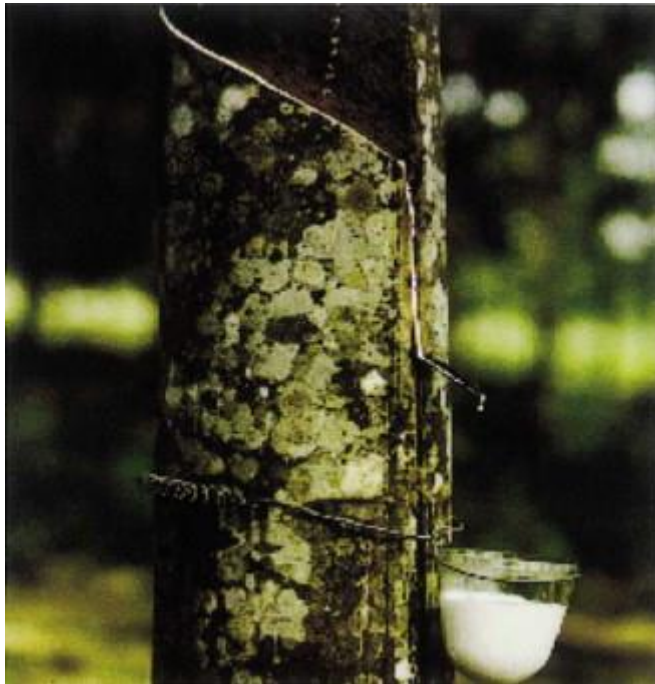
The Plantation Phase- it is the processing stages where tapping and latex collection activities occur. The methods of tapping and latex collection are the primary stages involved in rubber processing. In this stage the workers are given manual to guide them during the activities. The guidelines help the workers to know the depth the bark of the rubber tree should be removed. The girths of rubber trees are not uniform and the size varies in every plants. The manual entails different sizes of girth and the depth which applies to be removed. In efficient removal of bark or tapping can kill the plants. The tapping gauge tool is made from a metallic galvanized material to avoid rusting. The gauge is protected from rusting due to bacterial which can destroy the rubber drainage. Furthermore the latex collection procedure operates under the umbrella of plantation Phase. The processing is done at the plantation premises. The latex is well protected and handle with care from any disinfection. The latex collections are categories in two parts

at Ghana Rubber Estate Limited. The fresh latex collection and crumb latex collection. The fresh latex collection is the latex that is drain directly from the tree in to the storage container. They use half shell of coconut to collect the fresh latex from the tree. The coconut shells are mounted on the rubber tree and hocked with some steel wire to prevent falling. This kind of latex collection can have effect on the latex .The coconut shell is organic material that can decay or produces some enzymes or fungi that might have influence on the content of latex. The Crumb latex collection is done by collecting all the latex that are generated from the plant and transport into a big storage tank or into rubber drum. The tank of the rubber drum should be well dry and free from any disinfectant. In some countries they store latex in aluminum tanks. The idea of storing the product in such material is that most of aluminum tanks do not rust. It very good idea but it contribute to a high cost of labor. There will more weight exerted involved during transportation to the factory. Drying machines are normally used to clean the tanks before the latex will be pour into the tanks. This procedure give a clear note there is no disinfectant or foreign material in the aluminum tank or rubber tank. The figure below shows the collection of latex as the fresh collection.



Source: www.grelgh.com

Figure (6)



NR latex collected in a cup after skillful tapping of the bark of a *Hevea brasiliensis* tree.

Source: <http://www.sciencedirect.com/science/article/pii/S0091674902000982>

Figure (7) Fresh Latex collection

5.4 Factory Phase

The factory phase requires a high professional skills and knowledge to operate within the system. The factory phase technologies and systems in natural rubber processing stage are not familiar to polymer engineers or polymer chemist. The phase consist of latex preparation and machine operations .In the Latex preparation section latex preservation, latex compounding and latex concentration all are perform with in the same processing line. In addition most factories processed the latex in crepe rubber or in smoked sheet format. The latex is processed into crepe rubber format by adding small percentage of sodium bisulfite to the rubber. The sodium bisulfite serves as a bleaching agent. In absence of the sodium bisulfite the rubber is processes into sheet by rolling the coag-

ulum to increase in length for about 1mm to 2mm thick. The smoked sheet rubbers are done by drying the rolled sheet latex in smokehouses. The smokes are from burning of coconut shells or burning wood. [16]

The low ammonia and zinc oxide are used to preserve the latex for a long suitable period of time for storage. The preservation system increases the latex quality in the processing settling of particles or latex sieving, blending and packaging. In small rubber factories the use of ammonia as preservation still exist in their operation unlike large companies like Ghana Rubber Estate Limited and SOGB (Société des Caoutchoucs de Grand Béréby) an agro industrial company at Ivory Coast which deals in Natural in rubber plantation and latex processing. They do not use the ammonia frequently but rather chemical such as sodium pentachlorophanate, sodium salt of ethylene diamine tetraacetic and zinc alkyl dithiocarbonates. They prefer using such chemicals than the use of ammonia due to the cost involved and the ammonia need to be removed from the latex prior to product manufacturing stage. The latex may be poured into containers or into tanks during the preservation period and the container may polished with formaldehyde. The inner part is polished with formaldehyde for easy removal of latex or pouring of latex. The reaction of formaldehyde with ammonia is not a good scientific practice or it is not good for human respiratory system. This also serves as reason why large companies are not interested in ammonia as preservation agent. The amount of latex produced from the farm or the plantation phase is concentrated before processing into product. Natural Rubber Latex usually converted into two raw material and these are the liquid latex concentration and the dry rubber. The natural rubber has a very good market value when it is concentrated. The concentration of latex is done in commercial basis. Globally, there are about four different systems used in concentrating latex in rubber industries. The processes of rubber concentration are as follows:

- Latex Concentration by Creaming method
- Latex Concentration by Centrifugation
- Latex Concentration by Electro decantation
- Latex Concentration by Evaporation method

Among all the four concentration systems, only the first two methods are widely used in rubber industries. They are widely used in large scale and they are easily to apply. [17, 18]

Secondly they are very economical. The main idea of concentration the latex by process of creaming and centrifugation method is to increase the gravitational force of the rubber particles and also to reduce the non-rubber particle content. The process of concentrating the latex into creamed concentrate is by adding creaming agents like sodium and ammonium alginate, gum tragacanth and tamarind seed powder. The tamarind seed powder separates the latex into two layers. The lower layer concentrated and the upper layer concentrated. The lower layer concentrated latex contain serum made of little rubber contents and dry rubber contents of about 55%. The Concentration by Centrifugation processes are separated into two fractions. The fractions are categories based on the percentile contents of dry rubber level. There is about 8% of skim rubber latex which is coagulated with the help of sulphuric acid and 90% dry rubber content is processed for manufacturing product. The Bureau of Indian Standard (BIS) has given international standard requirement or codes on rubber latex centrifuged and creamed concentrated latex. The codes are given below in table (2)

Table (2) The International Standard codes on Latex Concentration by (BIS)

Source: www.rubberboardr.org

TYPES OF CONCENTRATED LATEX	INTERNATIONAL STANDARD CODE FOR LATEX IN INDIA
Centrifuged Latex	IS:5430-1981
Creamed Latex	IS:13101-1991

The Electro decantation concentration methods or process is mainly capitalized on the negative charge on tiny particles of the rubber. It is expensive methods and in-

volves electric equipment to obtain the process. Therefore it is not recommend for commercial purpose. The latex concentration by evaporation method is made up of small of non-rubber particles like coconuts shell tissues and ash .This tissues contaminates with the latex during the collection period at the farm. It also contains little amount of ammonia due to the stabilizing property. The concentrated latex will be blended with other additives such as, fillers, wetting agents, thickening agents, vulcanizing agents and stabilizers. The process of mixing additives to concentrated latex in order to increase its physical property is term as **Latex Compounding**. The blending of additives and elastomers in rubber Technology is to ensure that the product has reached efficient point. The importance of rubber compounding is as follows

- To control the viscosity level of the rubber
- To control the colloidal property of the latex
- To obtained the full efficient performance of the final product.
- To enable the product to be commercial useful.
- In order to meet the necessary processing parameters during vulcanizing.

The filler which is used as reinforcement agent are added to latex to increase the viscosity level of the compound and also enrich the properties of the rubber. There are several fillers used in latex technology application such as calcium carbonate, barium sulphate and lithopone. In latex Technology, the early stage of processing, the engineer can make a product out of processing by making ballons and soften toys. This can be done by softening the latex with paraffin wax and stearic acid. This soften agents will enable the film sheet to can be inflated. Practically this will allow the latex to be soft for easy inflated. The rubber latex usually changes from liquid stage to solid states with the help of thickening agents. The act of latex to transform from liquid stage to solid stages is term as colloidal. The process can be successful with addition of thickeners solutions to the latex such as alpha protein, casein, sodium polyacrylates and starch.

Furthermore in composite industries, the practice of impregnation glass fibers with latex is commonly used in construction turbines of aircraft. In this manufacturing line there will be need for the latex to be added with wetting agents such as mineral oil and castor oil. This helps easy penetration of latex into the fibers. The wetting agents will reduce

danger of destabilization of the latex. The natural rubber processing undergo second phase during the latex preparation at Ghana Rubber Estate Limited. The process is term as forming operation. In this operation there are extrusion, calendaring and milling. In the milling operation there will be need of the following agents to be presence in the operation. The agents are emulsifying agents, the antioxidants and dispersing agents. During the operation the latex surface is exposed and it is applicable also latex product. Due to the great surface area exposure there is a need for the latex to be protected against oxidation. The light has no change or impact of degradation of particles which has contaminated with the product. Moreover depends the environment for the operation, if there is possibility of stains particles can cause hindrances during the operation ketone amine and phenylene diamines is used as antioxidant to control or prevent the staining situation or contamination. According to the Rubber Manual book published by Dr. Utpal Kumar Niyogi of Shari Ram Institution for Industrial Research, India, He supported the efficient use of amine derivatives as antioxidant agent for against copper contamination during latex preparation which has effective degradation level for rubber. They support heat stability during the process. There are solid particles like stones and tissues which usually accidentally mixed with latex during preparation. The dispersing chemicals ensure all the intimate particles which have contact with rubber latex are settle down and the have reduce in sizes. There are about four categories which rubber compounders used for latex preparation. They may use Dipping, Casting and molding .Spreading, Spraying and foaming method. All these method are classified according to the procedure, shapes and equipment used for the preparation.[19].

5.5 The Machine Operations

There are three machine operations involved in latex processing in rubber factory. In this section the author will mainly base on the equipment and procedures which takes place at Ghana Rubber Estate Limited. The three main operations they used are rubber

extrusion, the milling and the calendaring. The three operations of rubber compounding lead to the final stage of rubber processing which is called vulcanizing or curing. The machine operation usually exists in dry natural rubber preparation. The mixing of chemical such as carbon black fillers with raw material of dry raw is used for production of automobile tires. In other hand the raw material of dry rubber which is used for production of engineering parts, foot wears tubing, adhesives and hoses. The common machines used for operation are the batch machines, rollers, the continuous chain machine, Slab cutter Machines, Hammer mill Machine, Granulator Cutter, Creeper machine and the Trolley Dryer Machine. Natural Rubber manufactures normally gives parameters and the dimensions for the machine fabricator to produce for them. The sizes of the machine are not uniform and it is produced by the suitable size of the natural rubber grower or manufactures. The batch machine is used for extrusion of the natural rubber. The operation of the machine is systematic and dipping process. It does not require any extremely technocrat ideas to operate the device. The machine is empowered with electricity to operate. [20]

The part of the machine also varies and it depend the request customer request. The purpose of the machine is to apply various agents to the rubber sheet which has been extruder by the roller head extruder or the open mixing mill. The price of the machine is calculated or estimated by power, diary capacity and voltage consumption. An enquiries made from the Dalian Datongweiyi Company limited, the price of one rubber batch machine is around \$5,000-18000\$. The total power of such machine is estimated to be 15.15KW and Voltage of 230V. The diary capacity is about 1.5 tons/ batch. [21]

The Batch machine for natural rubber processing

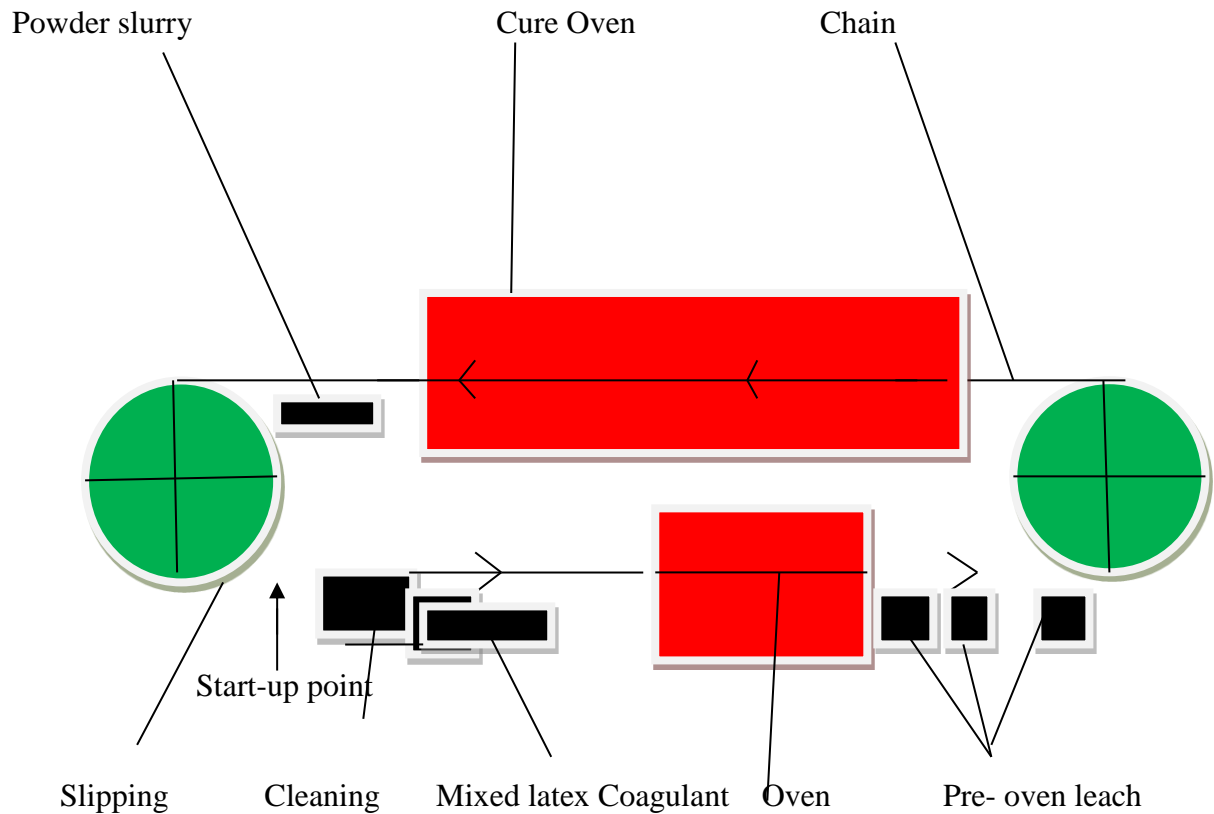


Figure10. Drawn by the Author

There are some general principles for the batch machine operation. The machine is very flexible and simple in terms of operation. The principles and operation of the batch machine are as follows:

Firstly, clean the surface of the machine with cleaning agents like alkaline solution, oxidizing agents, surfactants and acidic solution. The machine settings and the natural rubber crumb must be in line with the standard grade in the world market. Therefore the immediate procedure that takes place is by adding coagulant on the surface cleaned and this will control the amount of latex deposited into the mold. At times the coagulant thickness the latex and the calcium nitrate coagulant which is commonly used. The hammer mill machine is used for the latex coagulation. This type of coagulant serves as multifunctional agents as mold releaser and thickener. The more efficient and recommended chemical use as mold release agent is parting agent

which is called calcium carbonates. The small scale rubber processing industries use salt as mold release agents. The next stage is by transferring the rubber lumps or into furnace which has a very high intensive temperature. The rubber lumps will be pre oven leached by drying or entrapping all any residues like waters and proteins in the products. The machine commonly used for such operation is called the trolley dryer machine. It has an excellent work on drying lower grade latex with low rate fuel consumptions. The batch machine continue to perform the operation and the latex will be in oven again for curing. In the final stage after it has been cure, the latex or rubber lumps will be dipped into powder slurry chemical. It is immersed in a powder slurry chemical for viscosity reduction. In addition it serves as reinforcement agents by adding mechanical strength of the material. Finally the latex will be ready for packaging and transport. [22, 23]

5.6 Packaging

Packaging and design plays the major role in product development. The first remark or attraction a product or goods outwit from a customer or user is the packaging, because it is the outer most view section which every product can be identify. The first appearance of the product can be advertise or serve as a marketing tool for the goods. A product can be design and package to suit the keen interest of the customer due to three factors. The following factors need to be considered.

- The material selected for the product.
- The colour assigned to match the goods.
- The climates condition for the consumer.

The environmental hindrances such as waste pollution caused by petrochemical -based plastics material used for packaging due to the demands of high quality material from the customers .These material are non –degradable materials. The reason why which industries consider not using natural bio polymers for packaging are the low mechanical

strength and the low water resistance properties. The latex transported by Ghana Rubber Estate Limited is always packaged with polyethylene plastics film sheet. The colours of the sheets are normally black and green colour. They used non staining chemical for packaging. The chemical is commercial called **antioxidant 12**. It is a product from butylated reaction of p-cresol and dicyclopentadiene. The antioxidant 12 is used to avoid discoloring between the latex and plastics sheet for used for packaging. Sometimes there will excess amount of antioxidant will be used. This will have effects on human. Another chemical used for packaging is formaldehyde to increase the weight of the latex and for high commercial value. The required properties which has been designated by chemical engineers for **antioxidant 12^R** usage are as follows

- The product must be in white powder or flakes forms
- The specific gravity of the chemical must be 1.2g/cm^3
- The melting point should be 105°C

In the case of using the antioxidant excess the above parameters will not exist and then safety has not been put in to care and therefore accidents may occur or the environment may be put into danger. The latex is packed into boxes of wooden pallets. The weight of individual pallets might be approximately 60 kg [23]

5.7 Transportation

In logistics frame work the system of transporting the goods to the end customer falls under the distribution function. There are three types of logistics processes commonly practice in Ghana. The logistics processes are In house logistics, Tmi logistics and Third party logistics. Ghana rubber estate limited uses the in house logistics to run the company. In House logistics the companies employs logistics expertise who helps in taking care of transportation of their good in safest way and they have departments or section

in the company. These types of logistics processes is quite expensive, the logistics team earn annually salary of about 25000euros per year for individual worker. The Tmi logistics I t is a system of logistics processes where a software is used to manage the logistics processes in the company. The software assists or direct you how to manage the logistics systems in the company. It provide the links of shipping agents and shipping lines who have vessels to various country and update the regulation concerning transportation and freight agreement between two parties and countries. Lastly the third party logistics process is where by the company handles the transportation and shipping aspect to service providers. In Third party logistics systems the entire transportation is handle by the services provider. The service providers transport the goods from the warehouse and take care of packaging and all customs documentation involves in land and abroad.

The mode of transportation depends on the type of goods and the responds from the customer. In Africa, most of goods transported to abroad are by means of sea transports. The affordable method of transporting goods from Africa to other continents is through sea transports. The G.R.E.L, they practice the supply chain management systems. In this system the overall material flow and information flow are often used to manage the logistics phase. Dealing with the case of material flow the latex and rubber crumbs are collected from various tapping sectors and distributed to the sub divisional factories for processing. This is where the key factors of outboard logistics is been practice. In addition the company buys latex from individual rubber farmers or small scale rubber plantation firms for processing into large quantities. The G.R.E.L, purchase latex from other rubber out growers due to limited amount of latex tapped from their plantation in minor seasons. They have agreement with different customers in abroad .Therefore production or rubber processing needs to continue throughout the year to avoid breach of contract with their business partners. They always try to create a good relationship with their customers and it one of their goals to satisfy their customers to have value on their purchase. [24]

They have transportation chain in which it is used for exporting their product to overseas. For instance Germany, Italy., United Kingdom, Turkey and France .The charts below shows the transportation processes in Ghana Rubber Estate Limited.

TRANSPORTATION SYSTEM IN G.R.E.L

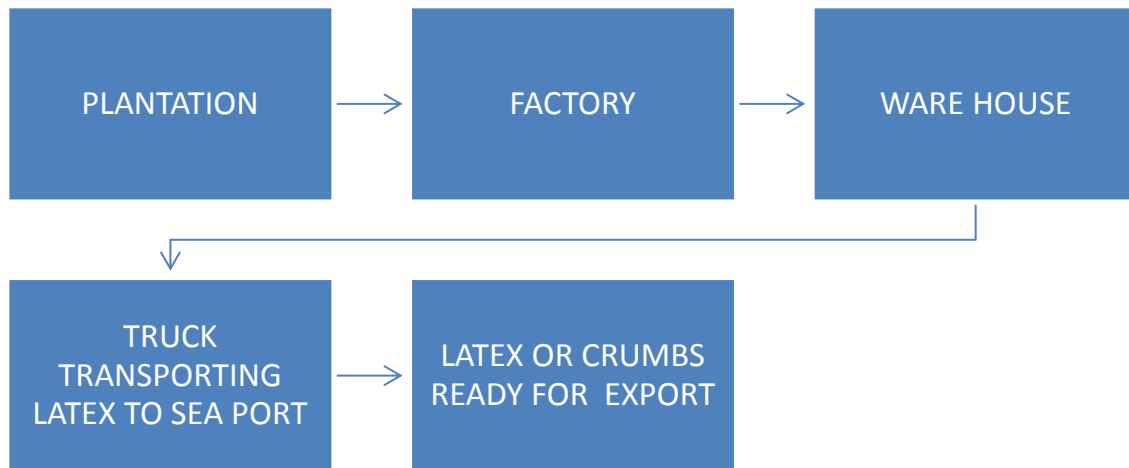


Figure (11) .The transportation system in GREL drawn by the author

6 CHAPTER6 -THE PROPERTIES AND APPLICATIONS OF NATURAL RUBBER

There are some general properties and application of natural rubber which are applicable in daily life activities or useful in engineering life.

6.1 Elastomeric property

Natural rubber has a very high molecular weight of about 100,000g/mol to 1,000,000g/mol and it has more than 80% content of hydrocarbon. The contents of polymers will be approximately 85% of hydrocarbon cis-1,4-polyisoprene. It has a high molecular weight due its long chain polymer and linear structure. The molecular weight of a dry rubber which is in a shear force situation, the viscosity analysis is used to calculate its relative assessment of molecular weight. The natural rubber possesses the gel and the sol phase. This promotes the cross-linked resistance in solvent. The natural rubber has very low temperature and this makes it able to crystallize and the regular structure have influence on the crystallization stage.

6.2 The Oxidation Property.

The raw natural rubber can be easily oxidized when it exposed to air. Since the rubber is made up of many double bonds in the polymer chains. The air and sun exposed to the material will broke into smaller chains, by the reaction with oxygen from the atmosphere, these reaction is catalyzed by the ultra violet radiation from sun .The number of chains in the material will increase and the length of the chain will be more shorter. The constituent can easily be reduced in proportion. A blend natural rubber it consists of moisture, acetone extract, protein, ash and hydrocarbon compounds which form rubber.

6.3 The Elasticity property

When a natural rubber is stretched, there is a decrease changes in elasticity and it will exhibit the racking property. This normally occurs at the elongation stage and it will develop a high fibrous structures. The oxidation and radiation reaction will affect the elasticity property of the rubber. The natural rubbers are naturally soft and silky in nature.

6.4 Thermal Property

The thermal property is very wide and it can be concluded that the natural rubbers are sensitive to heat. When there is a different in temperature, it will have effects on the latex. The natural rubber latex can freeze at 0 °C. Normally, it is noted that when natural rubber is continuously stretched, it losses some energy as a result of the stretching it rapidly. The loss heat is term as hysteresis.

6.5 The Natural Rubber Applications

The natural rubber has been the most preferable material in many engineering, medical and leisure's activities applications. This has resulted in the long fatigue duration and be moderate material in terms of cost. The high molecular weight which natural rubber has as a polymer, the polymer is extensively used in automobile industries, for production of automotive tyres. The automotive tyres should be rigid and able to resist abrasion. The rigidity property of natural rubber serves as excellent raw material for automotive tyres. Natural rubber extends it applications in varieties of products. The products are ranging from recreational products such as balloons, scythes to Seismic bearing. The elasticity properties of natural rubber, it is assume to be the ideal material for manufacturing medical products such as condoms, gastronomy tubes, hand gloves and catheters. The elastic property of latex is more incredibly essential in terms of condoms. This is because it is important for the condoms to be elastics in order to be easily fitted prior to sexual intercourse. During the intercourse there will be stress applied to the material for not breaking to avoid any unwanted pregnancy and sexual transmitted diseases. Another good role which latex plays in medical field is due to the stronger porous structure in latex, it is used for hand gloves and gastronomy tubes production for not allowing any smallest bacterial to enter the gloves and gastronomy tubes use during surgery. The natural rubber also have a great application of making life comfortable for human being, in the area of house hold equipment's and clothing's such as shoes, foam mattress, rain-coats and blending with other additives for cosmetic ology works. The heat reduction

behavior of natural rubber has been a tremendous achievement for production of foam mattress due to the ability of natural rubber to store strain energy. This is because there is disorder of molecules in latex when it is stretched. In actual fact the natural rubber releases heat when it is stretched and the entropy is decreased as a result. [25]

There are about thousands of product manufacture from natural rubber. In this work only five pictures of the product will be shown.

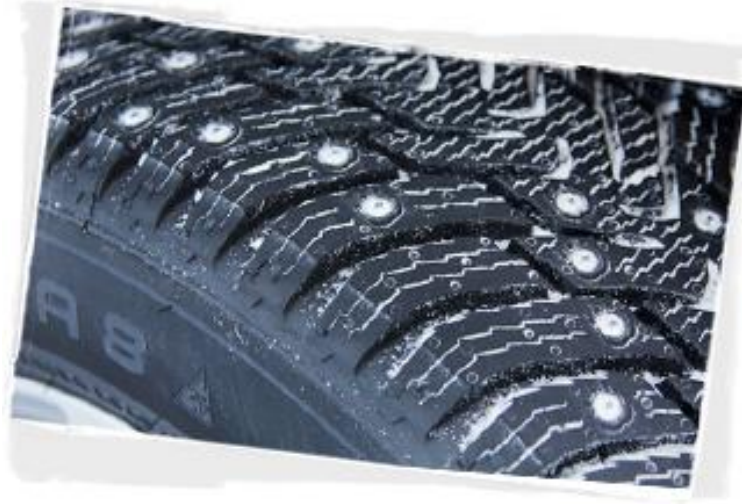


Figure12. Automobile Tyres

Source: www.nokiantyres.com



Figure13. Latex thin sheets and Foam mattresses

Source: patexfoam.com



Figure14. Latex medical disposal hand gloves

Source: www.healthgaurdproductcenter.com

6.5 Statistical Summary of World Natural Rubber

According to the rubber statistical bulletin published on July to September 2013. It was reported that the natural rubber consumption rate keep on increasing and the price per tone is also increasing as compare in last two years (2011 &2012). In table 3, drawn below explains the world natural rubber prices, production and consumption from 2011 to 2012.

Figure 15 World statistical summary of Natural Rubber Situation

Source: rubber statistical bulletin, July-September 2013 edition

WORLD NATURAL RUBBER STAISTICAL SUMMARY

NATURAL RUBBER PRODUCTION					Q1	Q2	Q3	Q4	2011 YEAR	Q1	Q2	Q3	Q4	2012 YEAR
Asia -Pacific					2414	2326	2834	2706	10280	2448	2420	2893	2763	10524
EMEA					110	100	131	131	472	118	113	128	134	493
Americas					83	89	62	69	303	85	90	65	72	312
TOTAL					2607	2515	3027	2906	11055	2651	2623	3086	2969	11329
NOTE: ALL FIQURES ARE TONNES					Q REPRESENT QUARTER OF THE YEAR									
NATURAL RUBBER CONSUMPTION														
Asia -Pacific					1670	1820	2087	1999	7576	1865	1958	2002	2078	7903
EMEA					316	333	318	275	1242	282	272	266	264	1084
Americas					111	107	100	103	421	100	94	266	264	724
TOTAL					2097	2260	2505	2377	9239	2247	2324	2534	2606	9711
NATURAL RUBBER PRICES					(ALL FIQURES ARE IN DOLLARS				TOTAL					TOTAL
SGX,RSS3,US\$/TONNE					5744	5300	4665	3607	19316	3855	3591	2970	3097	13513
SGX,TSR20,US\$/TONNE					5251	4670	4567	3589	18077	3702	3312	2750	2884	12648
EUROPE TSR 20, US\$/TONNE					5382	4807	4658	3700	18547	3767	3402	2847	2986	13002

6.6 Natural Rubber Production Quantities for Top Ten Countries

The top ten countries which produce high quantities of natural rubber are as follows in percentages

- Thailand-31%
- Indonesia-29.1%
- Malaysia-9.4%
- India-8.4%
- Vietnam-7.7%
- China-7.2%
- Cote divore-2.2%
- Brazil-1.6%

- Sri lanka-1.5%
- Nigeria-1.4%

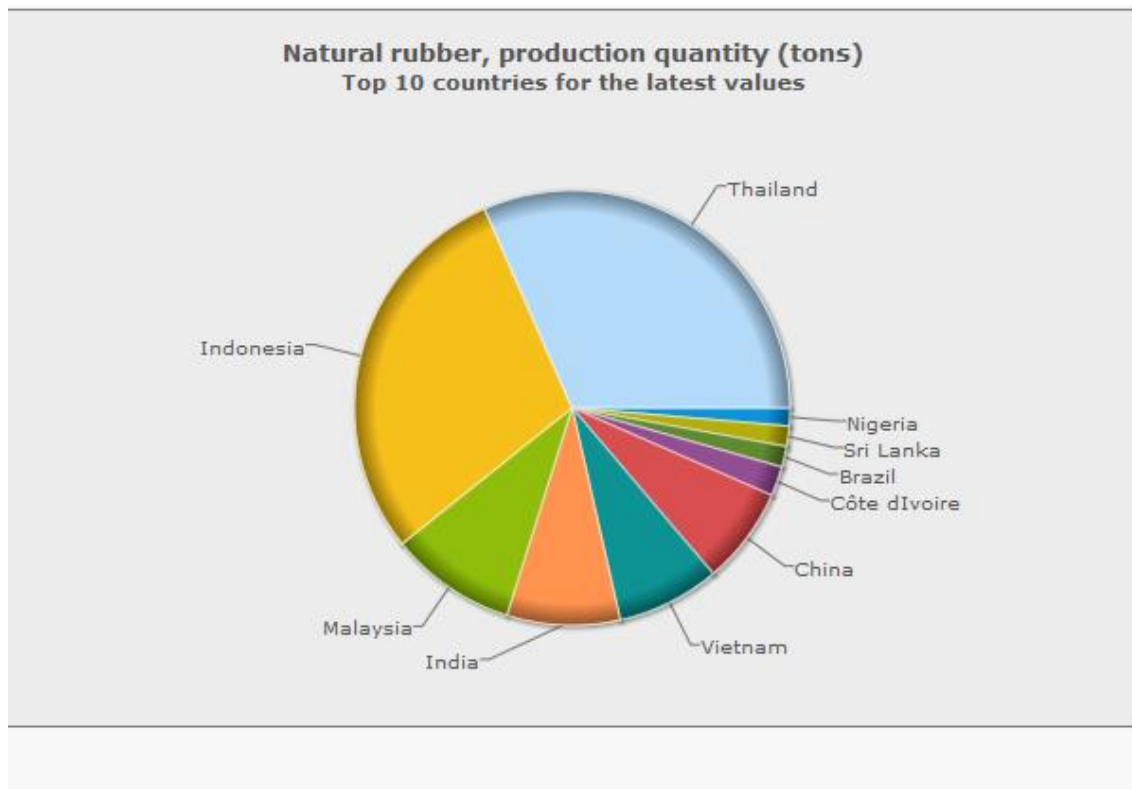


Figure16. The pie chart representing the top ten countries leading in natural rubber production in the 2011

Source: www.factfish.com

6.7 The Last twenty countries of Natural rubber production

There was a need to research on the last twenty countries of producing natural rubber in small quantities. This was done due to the segmented country of the dissertation which

is Ghana. Ghana falls under the last twenty countries of producing natural rubber. They represent 7.7% on the last twenty countries of natural rubber production pie chart. The figure 17 represent the pie chat of the least twenty countries in natural rubber produc-
tion.

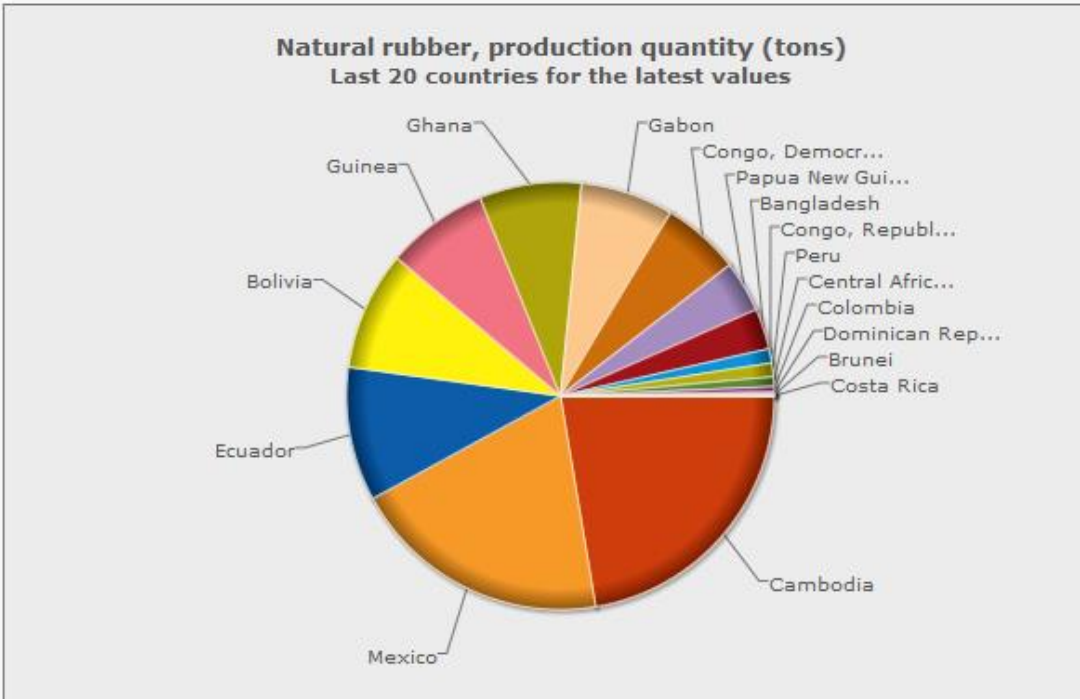


Figure 17.The Pie chart of last twenty countries in natural rubber production in the year 2011

Source: www.factfish.com

7 CHAPTER 7- SYNTHETIC RUBBER

7.1 General Concept of Synthetic Rubber

Generally, the idea of scientist discovering the synthetic rubber was the replacement of natural rubber prior to the Second World War. The concept started in Germany, where polymers were considered to be used for general purpose application and alternative solution for natural rubber. In critical moment of war time, it is very essential to make up for the lack of natural rubber distribution to the allies. This was to supply the rubber product to the grouped of people who come to an agreement to achieve the common goal on rubber production. In this manner, there was series of synthetic elastomers introduce into the system. The trading of rubber become so large that the merchandised of the polymer and was divided into general purpose and special purpose. The special purpose rubbers are the types which are produce in small quantities. They possess different properties in solvent, oiling and heat resistance as compare to general purpose rubber. The initial special rubbers which were inverted are neoprene and acrylonitrile-butadiene. The general purpose rubbers are produce in large quantities and they are in class of rubbers which can exhibits the non-oil resistant properties. In synthetic rubbers they have narrow molecular weight distribution. Their ability to exhibit strain crystallization is low. In this work only couple of synthetic rubbers will be discussed in this chapter. The synthetic rubbers are in different types and have different manufacturing systems. The types of synthetic rubbers which will be emphasized in this work are as follows:

- **Styrene- Butadiene Rubber(SBR)**
- **Polybutadiene**
- **Nitrile Rubber (NBR)**

7.2 Styrene -Butadiene Rubbers Composition and Properties

The Styrene-Butadiene Rubber is the most widely used synthetic rubber in the rubber industry. It is produced as a result of butadiene and styrene composition. They occur in cold polymerization and the styrene content is 25% and butadiene has 75% in the composition. The comparing level to natural rubber in terms of quality is poor and it has been able to penetrate into the market due to its buying price. It has been well known to every rubber manufacturer because of its non-resistance behavior to mineral oils. It is in different forms and grades. In the molecule chain one styrene weight corresponds to seven butadiene molecules per chain. The styrene butadiene rubber has thermal properties of long –term -40°C to 100°C , and the short term thermal property of 100°C to 120°C . They are used in manufacturing tire formulations, hoses and profile and foam rubber. Styrene butadiene rubbers are unsaturated hydrocarbon polymer and during the mastication the compounds do not break down entirely.

7.3 Nitrile Butadiene Rubber (NBR)

Nitrile Butadiene Rubber was discovered by Konrad and co-workers in 1930 during their research work at Germany. The nitrile butadiene rubber is produced by copolymerization of 1,3-butadiene and 20-50% acrylonitrile contents. They are classified as one of the special purpose rubbers. The NBR major production into commercial level started in 1937 by Farbenfabriken Bayer AG (Germany) which was named as PERBUNAN^R as the trade mark. The amount of butadiene to acrylonitrile can have effects on the property of the polymer. Formally nitrile manufactured was able to polymerize at temperature of 25°C to 50°C . The presence of acrylonitrile in the polymer increases compatibility contact in the polymer and it is able to resist abrasion. Nitrile Butadiene Rubber (NBR) fur-

ther extends its properties in terms of tensile strength and hardness. The outstanding property of the rubber makes it easy during processing. This gives an advantage to be selected by rubber compounders or engineers to use for rubber product manufacturing. The labour cost involved is limited due to less time involved in processing. They are useful in engineering material. They are essential in automobile sealing parts and also they are used as brake pads.

7.4 Polybutadiene

The polybutadiene was formerly produced by metallic sodium catalyzes polymerization of butadiene as complement for natural rubber. It is prepared by solution polymerization method. Normally a polymer with a narrow molecular weight sometimes becomes difficult during processing and polymerization of butadiene will have effect on the molecular weight distribution and obviously the polymer will be difficult to process. The polymer chain of polybutadiene is unsaturated and this will have effect on the polymer when there is oxygen, ozone and ultra violet rays not protected against the polybutadiene. In curing of the polybutadiene, sulphur and peroxides are used for such operation. The breaking down of the polymer during milling and mixing operation, there is a need to introduce peptizers. This agent will facilitate the processing and break down of the rubber. It is commonly used in the Scandinavia for automobile tyres production due to the good improvement of friction on ice. In shoes, conveyor and transmission manufacturing belt they are blended with other polymers for production due to the good improvement on abrasion and low temperature. There are other types of synthetic rubber these are neoprene rubber, ethylene-propylene rubber, butyl-rubber, chloro-butyl rubber, polysulfide rubber, Silicone rubber, Fluorocarbon elastomers and Thermoplastic elastomers. Only few synthetic rubbers which play more important in engineering life were emphasized on the research and the few which were not described details have similar properties compared with polybutadiene, nitrile butadiene rubber and styrene-butadiene rubber.[28]

7.5 Differences between Natural Rubber and Synthetic Rubber.

In global production: The natural rubber has been extensively decreasing in global level and the synthetic rubber is now increasing as compare in the twenty century. This effect or differences has been occurred due to the 2nd world war. During that era the synthetic rubber production increased as a result of large consumption rate of synthetic rubber over the Natural Rubber. [29]

Chemical modification: In terms of reaction, the natural rubber can react with other materials because it is grouped under the unsaturated organic compounds and it is very high reactive polymer and the reaction can occur by attachment of functional groups and the intra molecular changes which might occur. In other way it can be extensively reacts by grafting different polymers along the rubber molecule. As in the case of synthetic rubber the only ways which it can be modifies or produce is by polymerization reaction. In this polymerization reaction in synthetic rubber comes as a result of three forms of polymerization either free radical polymerization, ionic polymerization or the coordination polymerization. In the free radical polymerization heat or electrochemical chemical reactions are the key elements of producing the free radical initiators. In this situation or reaction the decomposition of peroxides, hydroperoxides can be the best initiators for the reactions.

The price index: The synthetic rubber has been relatively increased in prices as compare to the natural rubber which has taken the lead of increase in elastomer consumption over the past years. More over the natural rubber it is highly preferable for automobile tires because of it highly strength in elasticity and outstanding green strength.

The chemical structure or origin: The natural rubber is produced from extracting the inner bark of many trees and the synthetic rubber is produced from the crude oil [30]

7.6 Natural Rubber and Synthetic Rubber Similarities

In as much as there are several differences in natural and synthetic rubber properties. They have some similarities in common. Both rubbers are used in production of automobiles tyres and extending their application to the sole of sneakers boots manufacturing. In addition they have the same application procedure of manufacturing football. They are all classified as polymers. The minor varieties between their polymeric grouped is just that their grouped under natural and synthetic polymers.

In a research works they all play important role during scientific studies or investigation. Neither of the rubber type is classified as non-valuable material during experimental works. The natural rubber and synthetic rubber all can be scientifically identify by their chemical structure. Both natural rubber and synthetic rubber possess the vulcanization properties. The procedures or process used to vulcanize the natural polymer is the same as the synthetic rubber.

8 CHAPTER 8- THE IMPACT OF RUBBER PROCESSING AND PRODUCTION ON THE ENVIRONMENT

The manufacturing of rubber is made through processing and production procedure. In manufacturing concept anything consume by the society has it environmental impact. Rubber is a polymeric material massively consumed by the world.

8.1 Rubber Industrial and the Environment.

The first concept or the theory one must achieve concerning this chapter is by understanding the meaning of industrial and environment. In our modern terms, people interpret industry as the changes from agriculturally activities to manufacturing economy. Moreover this should not be the case because at beginning of latter days in nineteenth century there were industrial activities of extracting minerals from the grounds. In this

manner agriculture can also be consider to be an industry currently. There is a clear understanding in agriculture activities involving the extracting of raw resources of species in different kinds.

Additionally to the previous facts on industry meaning, the production of goods from raw materials obtained by the product that can have influence on the environment is term as environmental impact. The industrial activities may affect the environment or have impact on the environment negatively or positively. The industrial activities which might come as a result of industrial pollutant to the environment is negative impact on the environment and the activities which might promote the healthy life of individual or promote greener mark to the environment and individual is term as positive impact. In ecological term environment can be define as all components of our surrounding which comprises of air , the living organism and the food and drink mankind consume. It is clearly observed that all this environmental constituents are interconnected together. They all work in hand by depending one another for living or survival. For instance human being depends on food and meats for survival and reversely animal feed on grass-roots for living and human being prepare grass root for the feeds of animals. The continuation of these development result in as environmental problem. The environmental problem occurs in two different dimension or origin, the extensively rapid growth of the world population and the high rate of energy and material usage by individual is creating problem for the environment. These industrial activities in terms of production and processing affect the environment by destroying or having negative affect on the ecosystem and polluting the environment. The growth of industrial or expansion of industrial economy truly improves the wealthy standard of many nations but it is widely reported by many journals that most environmental contamination is being caused by industrial activities either processing of raw materials or production of newly product. Many industrial activities or processing there is released of carbon dioxide and other greenhouse gases into the atmosphere. This environmental problem is linked to the climate change but although other activities also contribute to the climate change.

8.2 The Environmental threats from rubber processing in Ghana

In previous chapters much words or literature has been described with the concept of rubber. The environmental threats is a risk assessment which will come as result of human and industry activities or transporting of raw material which can have negative impact on the environment. The impact of chemicals upon the ecological systems, which serves as environmental toxicology or ecotoxicology, the noise and other forms of pollution which might cause as a result of factory and mill operations, the non-sustainable usage of natural resources and energy, greenhouse gas emission and mishandling of solid waste will be defined as the main elements of environmental threats in rubber industry.

Rubber might be in certain stages before it reaches the market for consumption or sale. This stage involves the production or processing before it will reach the endpoint or the customer. During production and processing there are negatives impacts which have effect to the environment. The negative impact will have influence on the environment which will definitely have effect on human and the ecological system. The activities which contribute to the negative impact on the environment in processing and production of rubber are as follows

- The chemicals used on the environment
- Non sustainable usage of natural resources and effect of social economic life of Ghanaians
- Non biodiversity promotion
- The greenhouse gas emission
- Mishandling of solid waste and raw materials
- Noise and other pollution

The above negative impact can have influence on living organism and the environment during the rubber production and processing. The environmental threats can be further described as any activities of mankind which can deteriorate or have affect to the environment. These environmental risks may be analyzed in different forms during rubber

processing and production at Ghana Rubber Estate. The negative impact on the environment may be categorized into two forms namely the environmental threats and negative social economic impact on habitation

8.2.1 The Effect of Social Economic life and Non Sustainable of Natural Resource

The industrial economy growth and the monetary gained selfishness, Ghana Rubber Estate Limited, do not consider the welfare of the citizens as well as the social economic life of Ghanaians. In western region of Ghana, most of forest reserves have been destroyed for cultivation of Rubber Plantation. A small city called Morrison 22 kilometers away from the district capital, there was about twenty thousand trees of palm trees and cocoa grown as forest reserved and as a result of raw material shortage in the rubber industry, all have been cut down to replace rubber trees. In this cocoa and palm tree plantation there were other crops like cassava, garden eggs, pepper, coco yam and plantain grown in the plantation which serves as income generation for individuals and food are produced out of the plantation unlike the rubber plantation there will be no any vegetable or tuber crops grown in the plantation. In the western region, farming forms part of social economy activities of the citizens so when their farms are destroyed due to the industrial activities of rubber plantation expansion, definitely their social economic life of the people will be affected. Secondly watering of rubber seedlings of Ghana Rubber Estate is done by connecting pipes from the main water stream which serves as the water sources for a certain community to their rubber seedlings site. In dry seasons the company drained all the water from stream to take care of their rubber seedlings. When this problem arises the community suffers from water drought and it also has effects on the life and other organisms like cow, sheep and species of much kind. Additionally the natural resource has been used in excessively or unsustainably

The natural resource destroyers should regard the environment as the finite resource, although environmental policies have been laid down or instituted to regulate and check

the destruction of natural resource. In some countries people who involved in disturbing the environment are punished by paying some fines or serving prison sentences. In some cases there are monetary values which pay for the destruction of forest reserve by paying high market price on commercial crops when there is low output of commercial crops in one particular season. The monetary value and environmental policies cannot substitute the amount damaged caused by the forest reserved and infringement of Ghanaians social economic life and individual as a whole.

8.2.2 The Chemicals used on the ecological system

The mechanism which the industries operates or the sources that invade toxicological chemicals in the ecological system are as follows

- The controlling of pest and diseases,
- Processing of raw material,
- Natural source of cyanide in plants
- Machine and equipment maintenances

Pesticide, insecticide and fungicide chemicals are the agrochemicals products which agribusinesses commonly used to prevent the destroying of plants by harmful organisms which major threats to the development of the plants growth and the chemical exposure into the environment automatically become threats to the ecological system.

Large scale of agricultural business or factories in West Africa has employed the traditional systems of controlling pest and insect. The traditional system used for controlling the pests and insect are the prophylactic spraying. In prophylactic spraying method, oil based copper oxychloride powder is diluted with other bordeaux for spraying of the plants. This occurs when the abnormal leaf diseases attacked the plants. Phosphorous acid percentage of 0.16 is used for treatment of shoot root disease. The diseases can be

observed when a heavy rainfall occurs in the area of cultivation. The disease normally attacked nursery plants and immature plants on the field. It is normally recommended by agriculture extension officers that farmers can use Akomin and Phosject 4ml/l and metalaxyl mz 0.2% for the treatment of the plant diseases.

These described are chemicals which are widely used by Ghana Rubber Estate Limited. In most seasons when there are shortages of other chemicals, sodium alginate, pentachloronitro benzene, calaxin, bayleton, zinc phosphide, kelthane and sulphur are used as pesticides, insecticides and fungicides substitute for diseases and pest control.

In other way, the raw material is the core heart for production and processing in industrial environment. The raw material has to be protected against any pathogens and environmental component that can act as microorganism for destroying the purity level for production. The natural rubber industries preserve the raw material or prevent latex coagulation by adding the formic acid and alkaline solution such as ammonia, sodium hydroxide and potassium hydroxide. In the processing of raw material such chemicals described are used in the factory. It will probably have biological effects on organism living in the environment.

The natural rubber form part of species which contain the natural form of cyanide, cyanic glucoside. The presence of cyanide may result as evolution, as it fights against animals and insects from consuming and destroying the plant. Most animals can tolerate digesting small amounts, but during drought but the amount of the chemical in plants increases. As a result, animals could toxicities themselves by eating plants which have a high concentration of cyanic glucoside.

The main innovative idea of excellent performances of machines or equipment diary used is to check the maintainers and servicing of the tool. In Rubber industry conveyor belt, blast furnaces, rubber latex centrifuge separator machine, continuous chain machine, slab cutter machines, hammer mill machine, granulator Cutter, Creeper machine and the trolley dryer machine. The maintenances of the equipment and servicing of tools, volatile organic compounds such as acetone, ethanol, d-limonene, toluene and isopropyl alcohol are used for cleaning of the tools and also for other general purpose on machine servicing. These volatile organic compounds have the way of using them either indoor or outdoor environment. The degree of using the chemical can have effect on the environment due the measurement quantity in the process. These chemicals have

been essential for industrial processes and also production of necessity material for human consumption. The equipment have to be in a good condition to work efficiently for increase of productivity for the company .Therefore they can not hesitate of using and the mechanism will promote environmental threats.

8.2.3 Non Biodiversity Promotion

Biodiversity can be described as the act of diversity life in a particular environment. It can be grouped into three forms; namely species diversity, genetic diversity and ecological diversity. Species diversity are living organism or living things which inhabit in places like desert, tundra, rainforest and reefs. The ecological diversity is by enriching the inhabitant and increasing their number in the ecology system. The last is the genetic diversity which emphasis on certain genetic species for surviving of the diversity. In general if the diversity lack of such genetics elements or qualities, they will diminish and the species will die. In an environment where such practice is not recognized or system is abolished or deprived is term as non-biodiversity environment. In Ghana, company like Ghana Rubber Estate they normally used up the natural resources before they can be renewed and these entire act do not promote biodiversity as result over harvest the rubber trees and they do clear most of forest and draining wetland for agriculture purposes. When such practice continue in an area individual will not benefit from the diverse ecosystem [31]

8.2.4 The Greenhouse Gas Emission

The earth is bounded with an atmosphere which is made up as mixture of gases. It is very obvious that the sun is much hotter than the earth. The energy which the sun produces consists of radiation that passes through the atmosphere to the earth. The radiation from the sun keeps the earth warm. The heat which has been absorbed by the earth through the rays of the sun later reflects back into the atmosphere. This phenomenon

continues and the gases in the atmosphere partially resist or stop some heat entering into the space. Some of gases found in the atmosphere are said to be the greenhouse gases. They most common are ozone, methane, nitrous oxides, carbon dioxide and the water vapour. The ozone and water vapour gases are found naturally in the atmosphere. The methane gas is produced from cattle during digestion and it can also be produce from rice plantation in a paddy field, the methane gas comes also as a result of recovery of crude oil. When plants or trees decompose the nitrous oxides are produced, the gases are produce from energy production during combustions processes. The carbon dioxide is produce from the breath of animals and human always from combustion or organic material or as in energy production .The carbon dioxide sustains the life of plants and trees. A natural disaster like volcanoes also produces carbon dioxide. The natural phenomenon which spontaneously occurs between the earth, the atmosphere and the sun is term as the greenhouse effect. Ghana has been one of the world countries notable for rubber production. Rubber plantation is one of the agriculture businesses which are associated with emissions of greenhouse gases. The fresh latex production and other primary rubber primary product like concentrated latex, ribbed smoked sheet and block rubber product contribute to greenhouse gas emission. Addition the industrial activities of rubber mills, the largely use of synthetic fertilizer, burning of fossil fuel and cultivation of tropical forest for rubber production are major attribute of green gas emission [32]. The figure [18] below shows schematic overview of fresh latex production and other primary rubber products and it associates with greenhouse emission.

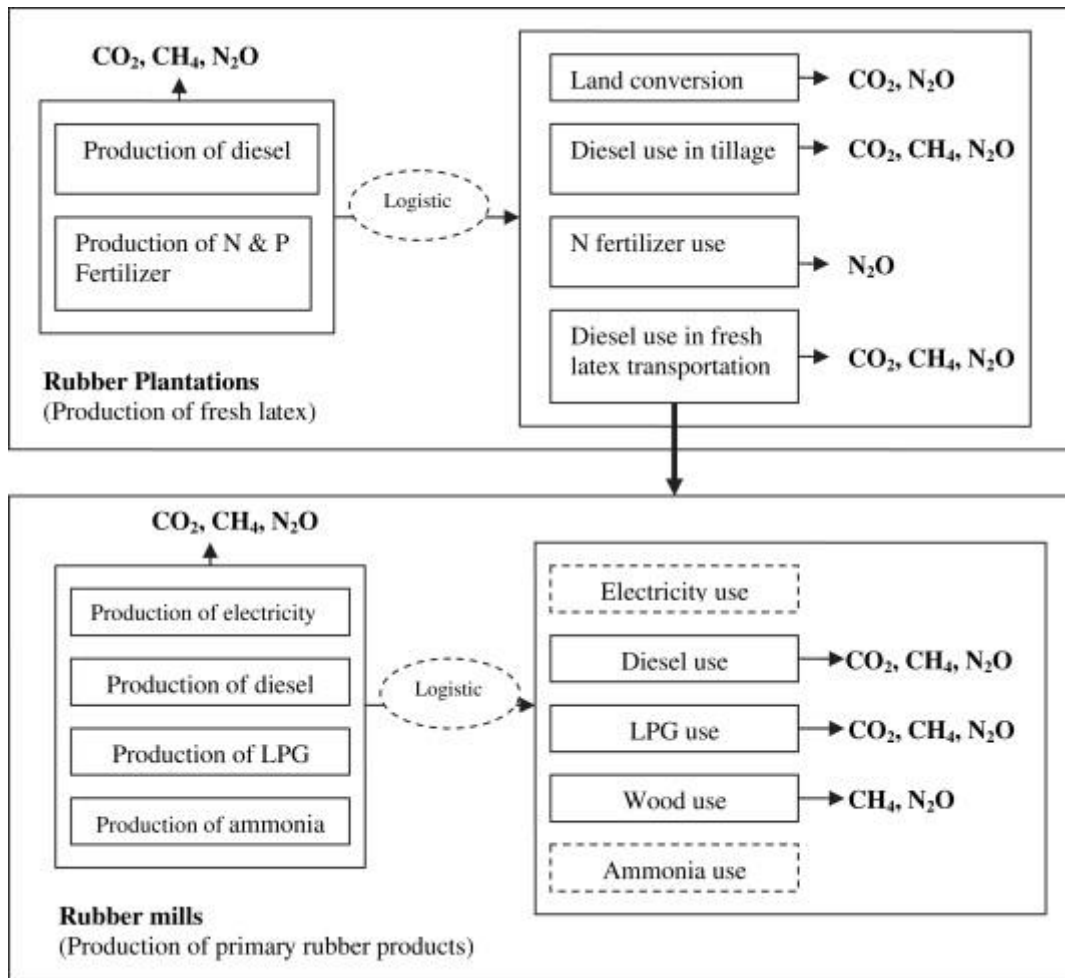


Figure 18 The schematic overview of fresh latex production

Source: <http://www.sciencedirect.com/science/article/pii/S0959652609003977>

8.2.5 Mishandling of Raw Material and Solid waste

The sources of raw material or origin of many engineering product has become more challenging scenario or has turn as rocket science to many material engineering student. The most essential hints on any raw material are either the material was obtained through mining or produce from plant or animal. They usually come in a form of natural form and not processed. A final product or finished products are manufactured from raw material and they serve as the basic material which final product depends on for market

value. An engineer will develop a product into the market based on the raw material durability analysis. The product cost price will be determined by the sales engineer due to the raw material life span and the cost value of the raw material as well as the manufacturing parameters taking into consideration. "For all things not been equal" the price of rubber neglect cannot be as the same of gold neglect. The raw material differentiates the price. The price of 1 gram of Gold will be expensive than 1 gram of natural latex in the world market. The economics behind model or theory is based on the raw material price. Therefore handling of raw material in industrial should be the most concern for workers or it should be considered as one of working ethics and conduct in manufacturing and production companies. The latex harvesting in Ghana Rubber Estate Limited is not considered as the key conduct in working environment. The type of mechanism or tool use for tapping rubber tree is not modern gauge and it can have effects on the fresh latex. The harvesting of the latex is done in traditional method by using coconut shells for storage of fresh latex. All these practices have economic and environmental impact on the company and the society as well. In proper harvesting of fresh latex will contribute in mishandling of raw material by fresh latex pouring on the grounds and it can have effect on the soil due to the cyanide contents in the natural rubber. In other way, the traditional knives used for tapping rubber are not galvanized and therefore the probability for rusting is high and due to the same cyanide compound property with metal. In an environment where solid waste is treated efficiently and management well promotes a healthy working life of the people. It further extends in an area of environmental disciplines. Empty aluminum canes left in the plantation after used for rubber nursery. They are non-decomposable material and they serve as a solid waste in the environment. The aluminum does not degrade and therefore it will serve as a toxic material against the enrichment of the soil contents and has effects on the rubber growth for efficient maturity.

8.2.6. Noise and other Pollution

The environmental science of physical principle and application book define noise as sound that is loud and eructating". The concept of eructating or disturbing cannot be measured. The content of disturbing level of noise according to the definition, then the device which will be used to determine the eructating amount of noise within a specific environment will be very cumbersome. The loudness of noise comes into relation with the human ear. The human ear is the only organ which could determine the frequency of loudness of noise. In some cases, some loudness will not be considered as noise due to the frequency and sensitive relationship with the ear. The sound which raped the entire meaning of noise can be also describe as a sound wave which propagated with velocity in a medium like air or concrete wall with help of pressure fluctuation. Several experiments have been performed reporting that the human ear can operate efficiently at frequency level of 4000[Hz]. The noise cannot be produced without any element coming into contact or without any source. In industries noise are initiated by the industrial processes which are at very high decibel. The industrial equipment's which can produce high level of decibel are grinders, extruders, injection molding machines, compressors and metal punchers. The high level of loud or noise can be considered as nuisance. The consistently practice of such activities can be term as noise pollution. In rubber processing, the rubber crumb will be compressed to a given shape and molded into a customized size to meet the customer requirement. Such processing creates noise in the environment because it comes with high level of decibel. The Rubber equipment's and machines produces a high level of loud noise which can bring the concern of environmental health and safety. The noise pollution cannot be considered as the only industrial pollution. There is much environmental pollution during industrial operation but only pollution caused by rubber production will be emphasized in the work. In Rubber processing and production land there are destruction of land, toxic chemical leak into streams and other chemical are released into the atmosphere. Therefore natural rubber production contributes in land pollution, water pollution and air pollution problems to the environment [33,34].

(Wiederkehr and Yoon, 1998) divided air pollutant into two categories; the traditional major air pollutant and the hazardous air pollutant. The organic compound made of major air pollutant comprises of nitrogen dioxide, carbon monoxide, sulphur dioxide. The hazardous air pollutant is made of chemical, physical and biological agents of different

kind of compounds. The concentration of hazardous in the atmosphere is lesser as compare to the major air pollutant. They are locally found in the urban areas and industrial geographical areas. The Sulphur dioxide presents in the atmosphere is sulphur been part of chemical composition in fossil fuels. The fuel quality is determined by the amount of sulphur content added to the fuel. A research has been made to find out the sulphur percentage in un-cleaned coal as 0.001%, oil percentage may be approximately 0.5%, gasoline 0.05% and there is no percentage of sulphur presents in natural gas. The pollution problems are resulted from various types of sources. The consistently and the level of releasing might varies from each problem. The issue of combustion could be the formation carbon dioxide. Industrial activities may contribute as the same source due to additive mixing into different concentration. The fertilizer application as manure, the ammonia and nitrous oxide produced may contribute to environmental pollution. The usage of non-degradable materials for packaging latex for export can serve as land pollution. The toxic liquids from untreated solid waste can drain into the soil by means of weathering processes and by an action of rains. This will kill the microorganisms in the soil and the nutrient balance will be less efficient. In Ghana there is a major problem of recycling plastics material. The waste plastic bags or nylon used for packaging are thrown into the refuse dump. The material serves as solid waste and it can have effect on the soil nutrient. The Non Methane Volatile Organic Compound used as solvent for industrial purposes, for example cleaning equipment and other chemical such as alkaline detergents, wetting agents and acid cleaning compounds are used for industrial cleaning. The drainage of industrial cleaning chemicals from the factory into main water stream pollutes the environment and in this manner there will be water pollution problem. In some cases where the solid waste contains chemicals such cadmium, mercury and lead can penetrate through the soil during a heavy rainfall and connect to other water bodies which have network to other water supply bodies, examples wells, rivers, lakes and sea .[35]

9 CHAPTER 9- METHOD AND MATERIAL

This section entails the research approach used in the study and further described the method used for soliciting information and interpreting the data for validity and reliability of the result. The general findings of the study are also outline in this section. The figure below [19] gives general principle overview of research methodology.

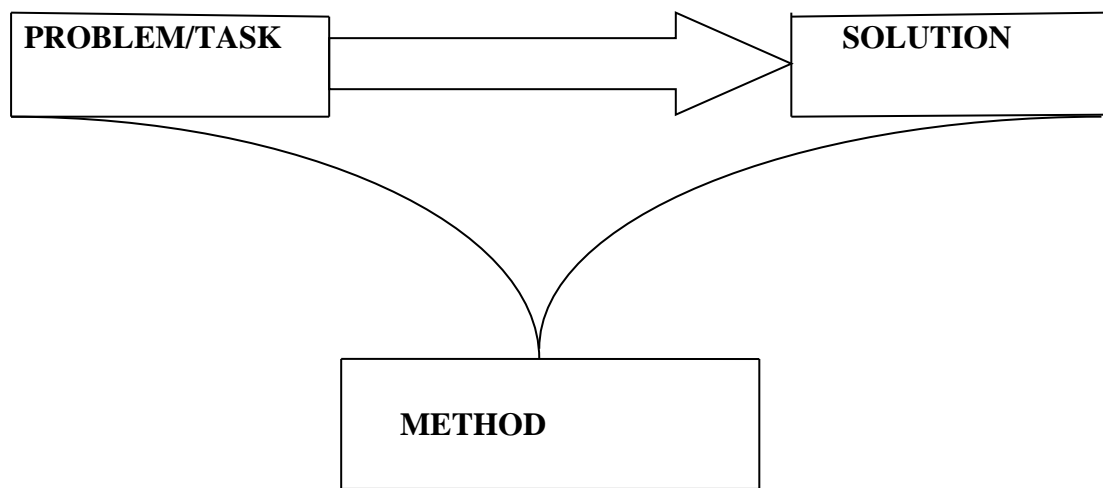


Figure 19 .The methodology principles

9.1 Research Methodology

Research methodology can be explained as the mechanism of collecting data and finding suitable tool to analyses the result. There are different ways of solving a task or problem by following the procedure and rules governing the study to obtain the result or the answer. The practical expects and the field work of the research motivated the researcher to employ both qualitative research methods and quantitative research method to obtain the data.

In the early stage of the work, the researcher outlined the procedure and method of obtaining information on the work as made mention of retrieving data through interview of expertise, conducting survey, using observational trials and other journal to analyses and present the data of the work. The qualitative research methods are research approach which result in obtaining a descriptive data. They are mostly used when investigating or gathering data, information on opinion, feeling, participant interpretation, processes and pattern as well as case studies and focused groups. In qualitative research usually result and data are expressed in numerical way or the information gathered is summarized in numerical system of interpretation. The qualitative research is useful in comparing information, obtaining measurement and testing hypothesis. The research problem of the thesis needed different opinion of rubber tappers to choose between the polypropylene design cup and the existing coconut shell so qualitative research was useful in this approach. There was a need to distribute questionnaire out to get information about the environmental pollution and to gather information or data about hazard chemicals used in the factory and health information of workers qualitative research approach was institute to gather data from the research. On the other way the researcher visits the premises of the plantation and the factory of the company used as case study to observe things and analyses data so the qualitative research played a major role in this research.

9.2 Data Collection

In a projects work or thesis work which consists of a survey, interviews and observation participant information gathered, the researcher will need data to analyses the result of the findings. In this thesis work primary and secondary data were used as source of data collection. The distribution of the questionnaire of the survey, the interview carried out in various department of the company, the opinion gathered from quality control officers and the rubber tappers about the switching of coconut shell to plastics cup as a device for collecting the fresh latex were used and the outcome of discussion and face to face interviews on environmental toxicity in the district with the environmental officers and chemical engineers were used as a primary data to obtain the result of the problems.

The scientific journals publication information, archival records gathered from various health centers and the company projected budget on medical bills for workers, which was announced during the annual general meetings, was used as secondary data for the dissertation to be accomplished. The survey on environmental threats during rubber processing was a qualitative research and 105 questionnaires were distributed and 90 questionnaires were answered correctly by the responders and 15 out of the 105 questionnaires answered wrongly. The survey lasted for twenty-eight days. I was able to distribute 95 questionnaires for the first two weeks I arrived in Ghana and I took a rest of one week interval and continued to distribute the 20 questionnaires which were left for the entire survey. The survey was conducted from 19th November 2013 to 16th December 2013. The formula used in table 3 is expressed and calculated mathematically as in equation [1]

$$n = \frac{\text{Number of Respondent}}{\text{Summation of Respondent}} \times 100\% \quad [1]$$

9.2.1 Statistics on the questionnaire

My visit to the farm plantation and the factory premises of Ghana Rubber Estate Limited Company, which was used as the case study, contributed a major factor in the observation participation information gathered and collected in table 3.

Table (3) The tabulated data on the questionnaires expressed in percentage

Age Group	Number of Respondent	Respondent in 100 % (n)
< 30	7	7.78 %
31-35	18	20%
36-40	35	38.9%
41-45	21	23.33%
46-50	9	10%

TOTAL	90	100%
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In this section of the research a cup which I designed with solid edge modelling software was printed and showed to selected rubber tappers to choose between the cup and the coconut shell which will be favorable and appropriate device for collecting the latex. Five workers were selected from five different farm plantations area namely Abura Zone, Nsueam Zone, Agona Zone, Dixcove Zone and Apimanim Zone. The rubber tappers were selected from the five zonal areas as a sample for the entire population of the workers to rate quality level of the plastics cup and the coconut shell as the best device to be used for latex collection from 5 to 100 %.The outcome of the data gathered which I used to analyses the mishandling of raw material in the company and disposal of solid waste problem. The data was expressed into different bar charts in which the result was obtained. The table below indicates the rating marks of each worker in the plantation zone.

9.2.2 The statistics on plastics cup and the coconut shell opinions.

The data expressed in the table 4 are the opinion pull from selected representatives of different zonal rubber tappers of the Ghana Rubber Estate Limited.

The mishandling of raw material problem was solved by designing the plastics cup and comparing with coconut shell for the rubber tappers to rank the quality level of both devices. The solid modelling draft of the designed plastics cup can be located at the appendix section

Table 4 .The Quality rating of the plastics and coconuts shell

Zonal	Plastics Cup	Coconut shell	No opinion
70			

Abura	65 %	30 %	5%
Nsueam	70%	25 %	5%
Agona	85%	10%	5%
Dixcove	60%	20%	20%
Apimanin	68%	32%	0%

Source: Data from the opinion of rubber tappers.

9.2.3 Data on the interview and responds

The questions and answers of the face to face interview and discussions of the expertise on the environment and other engineers has expressed below.

Table 5.The interview and the discussions of Expertise on the environment

Source of Data	Participants	Period	Topics
Interviews	Environmental officer	45 minutes	Environmental health and safety
	Chemical Engineer	I hour	Pollution Control
Discussions	Water & Sanit. officer	2 hours	Water treatment

Interview questions to the Environmental Engineer

1. What is the environmental condition in Ahanta West District?
2. How do you advice citizens and companies on the environment
3. How will you describe the activities of the companies to the environment?

Interview Responds by the environmental officer.

“I have been the district environmental officer for two years in Ahanta West District. Therefore I can boldly answer your question based on Life cycle assessment training organize for the communities in the district and the outcome of the seminar , I will con-

clude by considering the district as the deteriorating and polluted environment among the district in western region. Secondly I do recommend the companies and citizens of the district to be environmental friendly by caring much about the ecosystems and keeping the nature clean as well as the environment. The health safeties of an employee in other industries are not properly taking care or considered. In this matter proper safety equipment's like hand gloves, noise protected devices and musk should be provided for workers against accidents and other solid waste such as industrial waste and domestic waste should be treated in a proper way for not polluting the environment. The last question, I might be frankly speaking, someone will say am trying to subjective but that is not the case. The issue which matters most in this case of scenario is protecting the environment. There are numerous industrial activities like timber cutting, Coal and Gold mining and Nature Rubber processing in the region. These industrial activities have a big influence on the environments and their industrial operation serve as environmental threats to the district. A practically evidence can be draw on the demonstration of Ahanta West District Citizens against the machines disturbances during day and night by Ghana Rubber Estate Limited. This is a practical example of environmental threats by industrial activities."

Interview questions to the Chemical Engineer at GREL

1. What role does a chemical play in this Agriculture Industrial?
2. What are the chemicals used in the company?
3. What comment do you have on these chemicals?

Responds on the Interview

"Practically chemical is any substance comprises of matter which has a constant chemical composition and characteristics properties. They are in a form of plasma, gas, liquid and solid when the chemical bond are not breaking and it cannot be separated by physical means. Chemicals are very essential agents in this agriculture business. In plantation process, there will be chemicals needed to prevent herbivores and pest to destroy the plants at the early stage of plantation. These are diseases and pest control stages in rubber plantation. Pesticide, insecticide and fungicide treatment all are chem-

ical applications used by the farmers in Ghana Rubber Estate Limited are chloronitro benzene, Calaxin^R, Bayleton^R, zinc phosphide, Kelthane^R and sulphur. In coagulation stage where the latex are prevented from coagulating or preventing from building extra bonds such chemicals are used alkaline solution like sodium hydroxide, ammonia and potassium hydroxide are used to prevent latex coagulation. Other chemicals are used in the final stage of processing which are binding agents and removal agents like acetone and antioxidant. In my opinion the chemical use by the industries can be resulted in land pollution, air pollution and water pollution. In a case of protecting the environment the processing should be considered. The industrial emission steam must be pre-treated; the air dilution mechanism must be practice by industries. Industrial chemicals must be avoided as they normally transport into water supply sources. Solid waste created by the company must be properly recycled to avoid land pollution to the environment. All these industrial practice have effect environment and human as well”.

DISCUSSION ON TABLE (5)

A brief discussion was held for couple of hours between the water and sanitation officer in Ahanta west District and the water community board. Their views expressed during the meeting helped in solving other critical problems of the work. The issues which were deliberated during the discussion are as follows

- ***The water quality level, purification and treatment***

The discussion on the water quality had a positive impact on the research. The community board chairman and water sanitation officer in the district expressed concern about the water pollution situation in the district and the subsequent effect could have on individuals. The only source of drinking water in the district was hand-dug wells, bore holes, streams and ponds. According to the statistics of the district currently there are 151 bore holes, 62 hand -dug well fitted with water pump and about 600 unprotected wells. In this situation the untreated solid waste generated by the rubber processing industrial in the district will definitely affect the source of drinking water. The refuse or solid waste of rubber factory contains some toxic chemicals which can be transported into the water supply sources in the district when there is heavy rainfall. Since all the water generate through underground means. They emphasized that although there is numerous water pollution activities taking place in the district by rubber processing companies which has increase the water borne or water related diseases in previous years but they are improving on the water quality level through purification processes. Through the discussion, the purification of water techniques processes was useful information to the researcher and I gained deep knowledge on different types of water treatment. Water purification method such as settling, which also called sedimentation method, filtration and chemical disinfection method. The treatment technique employed by the water and sanitation officer in the district has improved water quality level significantly and the diseases have been reduced. They normally used ozone treatment, membrane treatment and ultra violet treatment process for water treatment.

9.2.4 The Use of Health Information

The retrieving of health information from various health centers helped to know the type of diseases which usually reported in the hospital. The leading diseases reported at

the health centers are malaria and followed by respiratory acute diseases which usually cause by air pollution. There was increase in skin diseases according to the data collected from the Ahanta west District health directorate. The table below show number of cases of patient reported on skin diseases and acute respiratory diseases from 2009 to 2010 at Ahanta West District where the rubber is been processed. The information or the data was collected from the ten leading causes of morbidity chart in the Ahanta West district health directorate table. This information can be found in most of the health centers in the district. The information enables me to follow the rapid increase of airborne and other disease which might cause by water pollution and air pollution. The information in table 6 represent the data retrieved from health directorate.

Table 6. Cases on Respiratory and Skin Diseases

DISEASES	YEAR 2009	YEAR 2010
Skin diseases	8785	9142
Acute Respiratory diseases	6933	7341

Source: Ahanta West District Health Directorate.

9.3 Reliability and Validity

A good research work will be evaluated based on the reliability and validity assessment. The reliability of the work can be graded for the trustworthiness and authenticity which the researcher implemented in the work. It can be considered in a different angle or explained in concept of another person working on the same research. The reliability of the work can be achieved when both of the researchers get similar result. This is where the work can be credible assessed as reliable work. In the first part of the work which was the survey, the reliability matters most in this section because there will be a greater effect on the result when the data collected from the field was not gathered from reliable source. In addition qualified expertise was interview to be able to get authentic opinion

from their rich practical experience for modelling the problem. In the area of validity of a research work, the data collected have to be correctly described and documented in a way it can easily be interpreted for a good recommendation and conclusion. The descriptive data such as percentage ranking between the plastic cup and the existing coconut shell were vividly recorded as the rubber tapper expressed his or her opinion to avoid any criticism and critical data recording which might turn the work into bias result due the influence by the researcher perception on the general thesis work. I tried to distribute the questionnaires with in the geographical area where the rubber plantation are taken place. This will give more credibility of the work. In the interview I tried to formulate the question by not given a room for the respondent to be subjective and bias on the information collecting.

CHAPTER 10 -EMPERICAL STUDIES

In this section the data collected from the survey, the opinions from various target groups and information from the archival sources are quantified, interpreted and ana-

lyzed with empirical evidence. In other hand the result from the studies and the research are presented in a chart under the empirical studies.

10. 1 The presentation of survey result and analysis

10.1.1 Age grouping

The age grouping was the first question asks by the respondent in this questionnaire. In Ghanaiaans labour Market. It has been predicted that the age between 31 years old to 45 years old are always active at work.

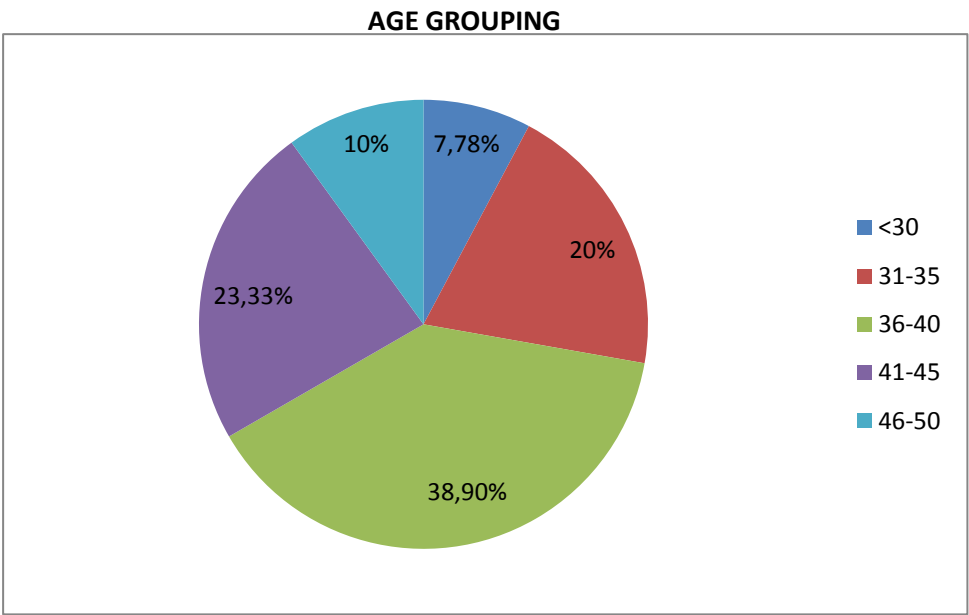


Figure 20 : Age Grouping

The age below 30 years are mostly likely to be in the school and the age between 31 years old to 35 years old are national service personnel. The tertiary institutions in the Country is limited for the population. Student might graduate from high school and have excellent grades but admission requirement for the institution might disqualifies him or her to enroll in the same year. Sometimes student waits for the next two academ-

ic years before he or she can enroll into the tertiary institution. This will have effects on the working age of the labour market and it can be analyzed from the figure 20 that the ages below 30 years have the least value on the chart and the age between 36 years old to 40years old is dominated as the highest percentage value recorded on the survey due to their active participation in the labour market. The second highest value recorded was the age between 41 years old to 45 years old. In this case people who normally had their education through distance education or part time studies are estimated to start working in that age. The age recorded as 10% was the second least value recorded. This is because in that age people are not interested to work with industries and prefer to do commercial trading or farming due to the health and in the ages of 41years old to 45 years the immune system is not strong as ages between 36 years to 40 years old. The age grouping was necessary to be included in the questionnaire because during recruitment of workers at Ghana Rubber Estate Limited, been used as the case study of the thesis, age are consider due to the industrial activities of the company .In this section the researcher was able to analyses the effect which their industrial processes have on the labour environment

10.1.2 Area of Residence

The area of residence in the survey was very essential question to be included in the questionnaire.

Area of Residence

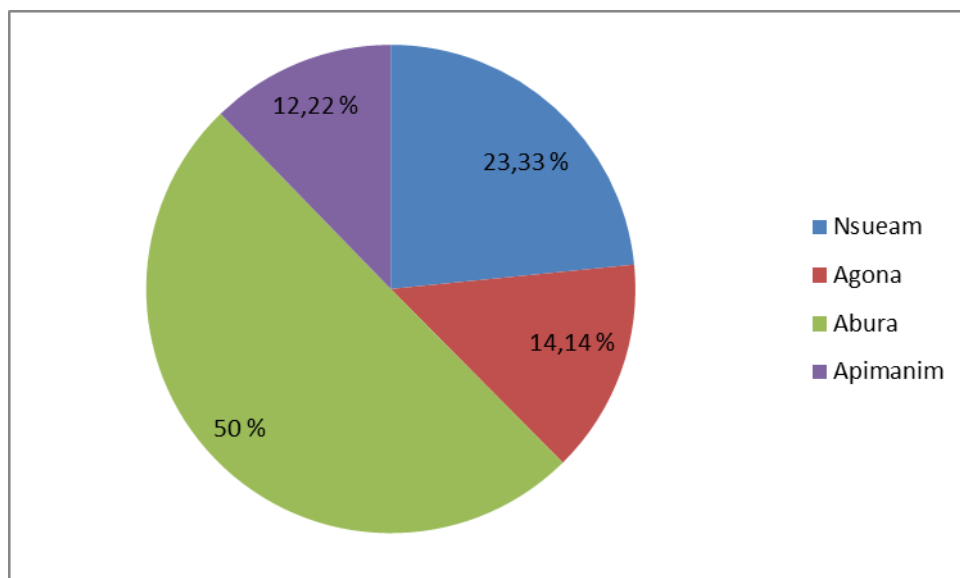


Figure 21. Area of Residence.

The area of residence in the survey was very essential question to be included in the questionnaire. This was able to quantify and analyses the places where Ghana Rubber Estate limited highly operates and area where workers are highly affected by the environmental threats. The Abura area is the highest place where rubber plantation is highly cultivated and they have a lot of workers. The facts cannot be dispute according to statistics of the company and the survey has proof as well. It is the area where people have ground water as their source of drinking water. Therefore their environment is highly threatened by the rubber industrial.

10.1.3 Gender Distribution

Male-Female Responds

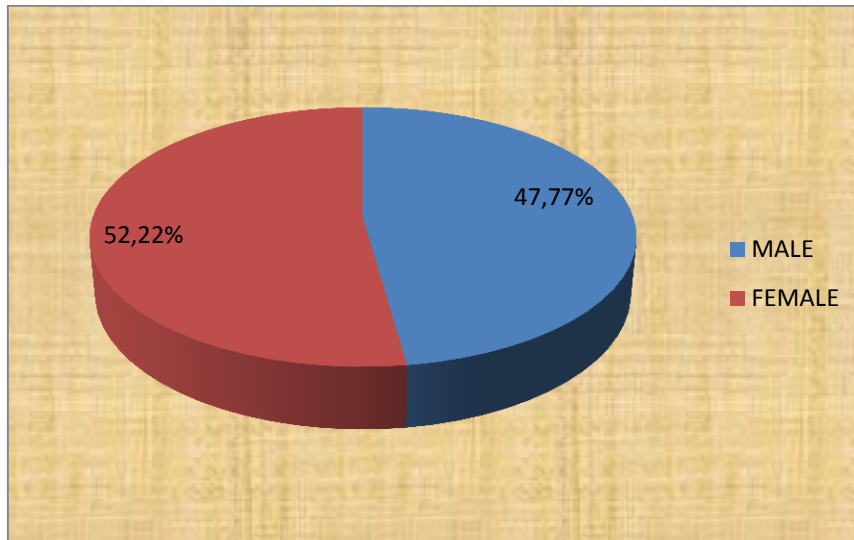


Figure 22. Male –Female Gender distribution

In the gender distribution, it clarifies and illustrates the amount of male and female who answered the questionnaire or responded to the questionnaire. The questionnaire was distributed within all the premises of the Ghana Rubber Estate Limited. About 70% respondent of the questionnaire were workers of Ghana Rubber Estate Limited. In Ghanaian recent population census females have the highest population in the country. In Ghana Rubber Estate Limited, Females are highly populated in the nursery department and the agriculture business. In the nursery stage was highly toxicities and harmful chemicals are used for diseases control. The gender distribution processes facilitate the researcher to know those who are likely to be more affected by the environment threats. In other hand few males in Ghana uses farming as their profession and the effect of social economic life problem will not have greater influence on the men. Several women solely depend on farming output as their main source of income. In such situation the agriculture activities of Ghanaian Rubber Estate will have greater impact on the society as the female have the greater population in the survey as well as in the country.

10.1.4 Occupational Sectors

The sector of employment needed to be utilized in the survey. The Ghana Rubber Estate Limited Company is managed by the private individuals and Ghana government also partially manages and owned some shares in the company

Employment Sector

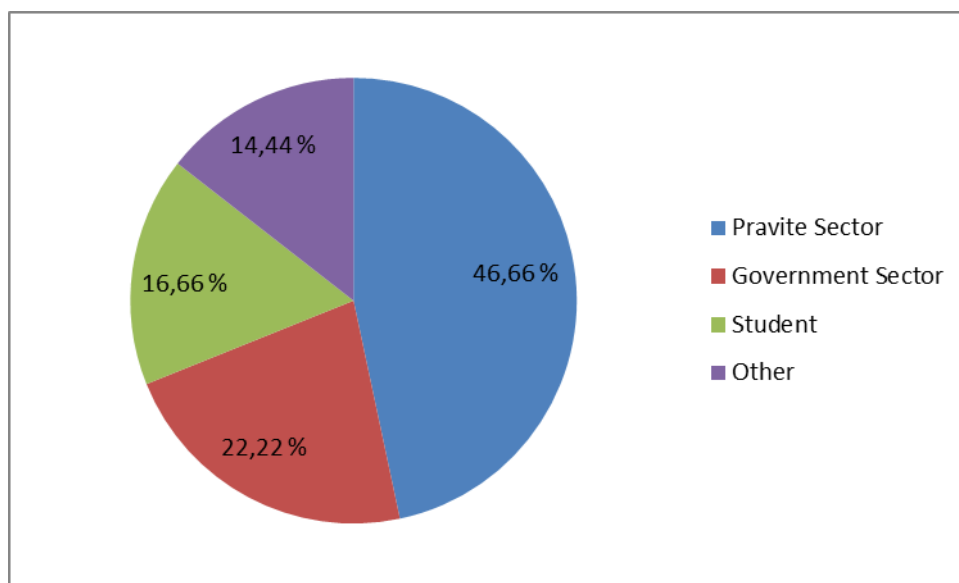


Figure 23. Employment Sector

In the survey the private sector and the government sector recorded the highest percentage value on the chart. The information on the sector categories was useful in the survey. The government sector and the private sectors have different health insurance scheme for individual workers operating within the same organization, Ghana Rubber Estate Limited. The students doing their internships are covered by their school health insurance. The private workers are covered by health insurance which is very expensive and it really has effects on the company yearly profit and the Ghana government subsi-

dies insurance cost for those workers who were employed through ministry of agriculture of Ghana. The private employees who are working at high risk environment like the nursery department, the factory and plantation field.

10.1.5. Water and Air Quality Satisfaction

The water and air quality level of each individual or the workers were accessed through the questionnaire. 43.33% of the respondents are not satisfied about the water and the air quality level of the city.

Water and Air Quality satisfaction

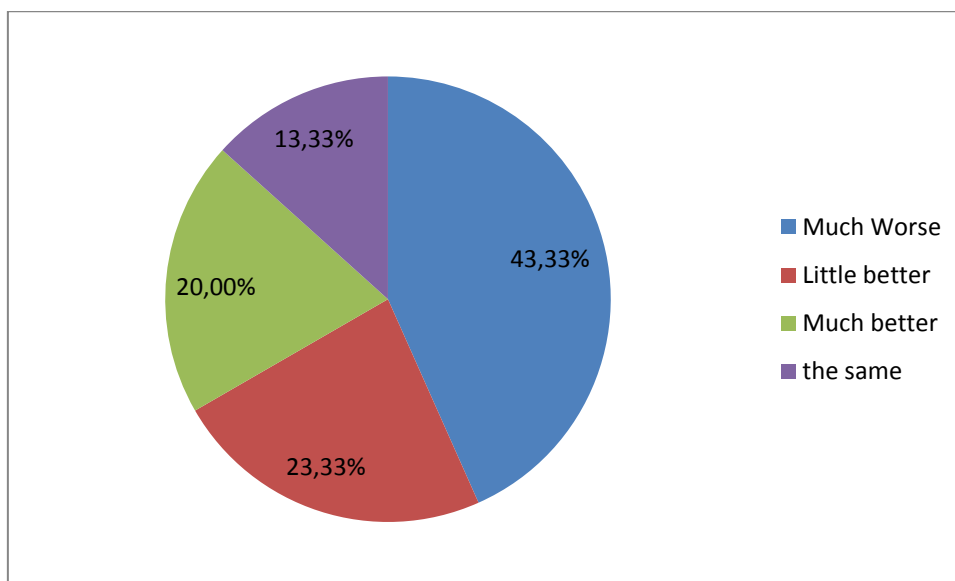


Figure 24. Water and Air Quality

This justify that the rubber processing has an environmental threats to the society. About half of the respondents were not happy about the water and quality level of the city and these shows there are environmental problems in the city.

10.1.6 Drinking Water Source

The majority of habitant living in Ahanta west district uses ground water for their diary activities. In the survey almost the respondents choose ground water as their source of drinking water supply. In figure 25, the river stream recorded as the highest source of drinking water for the workers as indicated on the chart below

Sources of Drinking Water

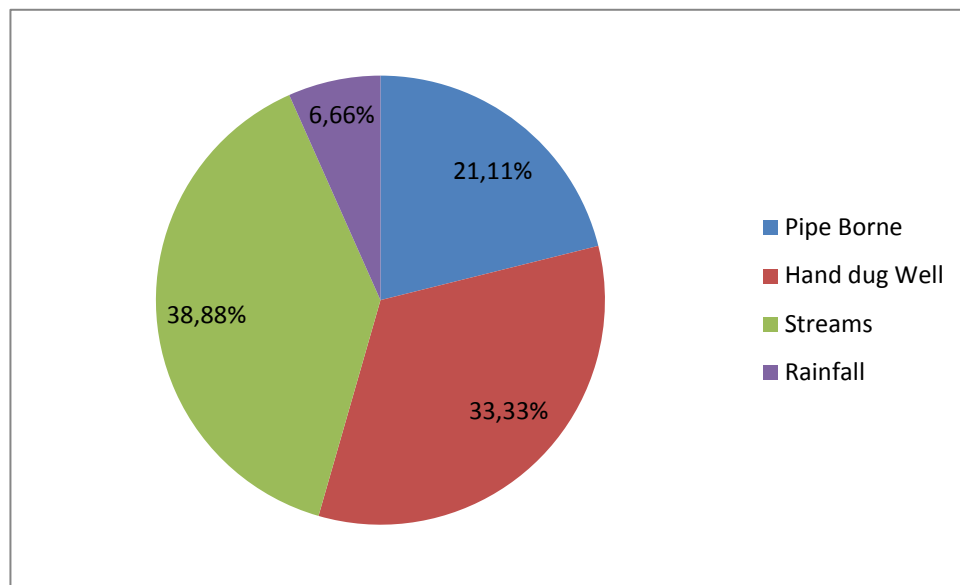


Figure25. Sources of drinking water.

The tendency of polluting the environment is high, since there are majority of river streams in the city and most of the industrial liquid waste are channel into the river stream. In this practice the environment is polluted and has effects on the eco system.

10.1.7 Causes of Pollution

In a real life situation all the activities under the chart are agents of pollution. The one which will be much emphasizes is the highest pollutant and it toxicity level to the environment. In this section the respondent were given a chance to express their views on the several practice or activities of mankind which are contribute to environmental pollution.

Activities of pollution

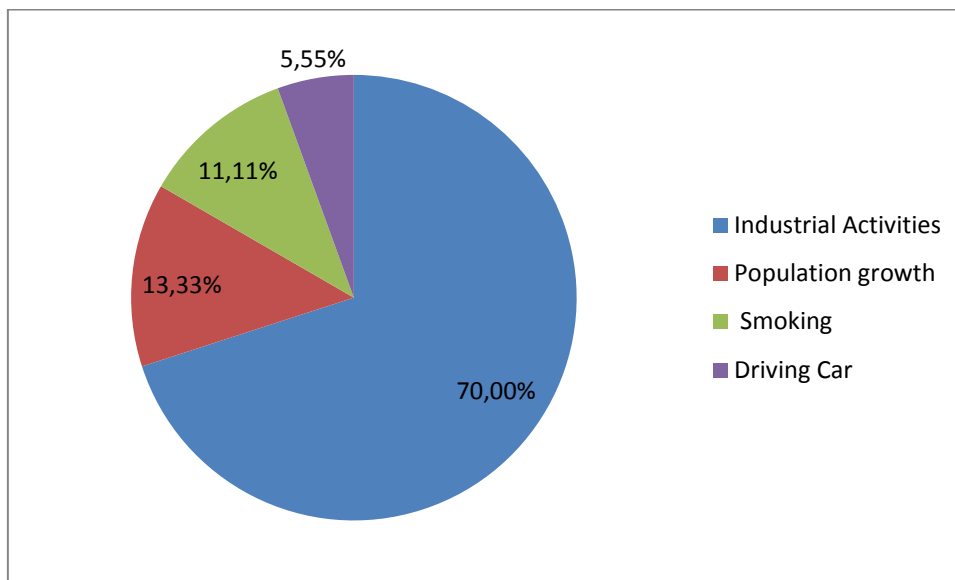


Figure 26 Activities of Pollution

There was 70% mark for industrial activities which is the highest among the activities. The Ghana Rubber Estate Limited operates as an industrial and therefore the possibility of a crediting the survey data collected as factual information is realistic. The percentile of each activities of the outcome from the survey is indicated on the figure 26

10.1.8 Polluting Companies

The companies under the chart are processing company. In processing any product the probability of exhibiting industrial waste and pollutant are high. The Ghana Rubber Estate Limited been the case study of the thesis were recorded as the highest industry which pollutes the environment among the selected industries. Intex and Depaul are wood processing industries and Norpalm is palm fruit processing companies. The truth of the content cannot be ruled out. In as much as there are several chemicals been used to process the rubber latex then the wood and palm nut fruit the rubber industrial will definitely be highly threatened by the environment due the chemicals influence on their products.

Pollution Companies

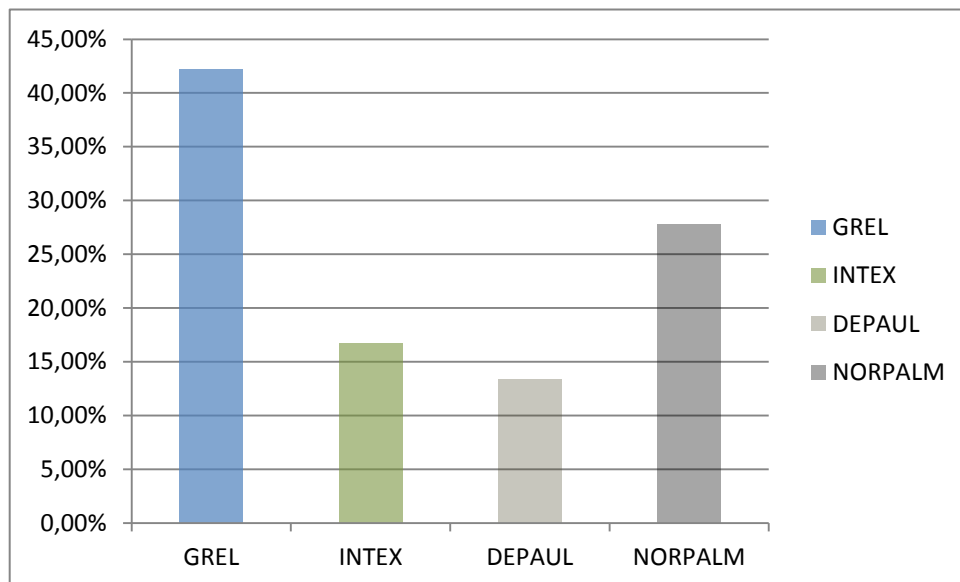


Figure 27 Pollution Companies

The Ghana Rubber Estate Limited processes their raw material, the latex obtained from natural rubber tree in various stages. There is no single stage of rubber processing which chemical will not be added to the raw material. Chemicals are added from the raw material storage to the final product storage.

10.1.9 Society Protection on Environment.

In a society where the surrounding is not hygienic, the individual’s residence in the designated environment suffers the consequences. In the survey, the opinion on the natural environment protection and its essential elements were addressed in the questionnaire. The key element and theories about the question based on clean environment promotion and environmental regulation. The questionnaire on environmental protection drew an excellent consent of environment degradation resistance of the society.

Environmental Concern

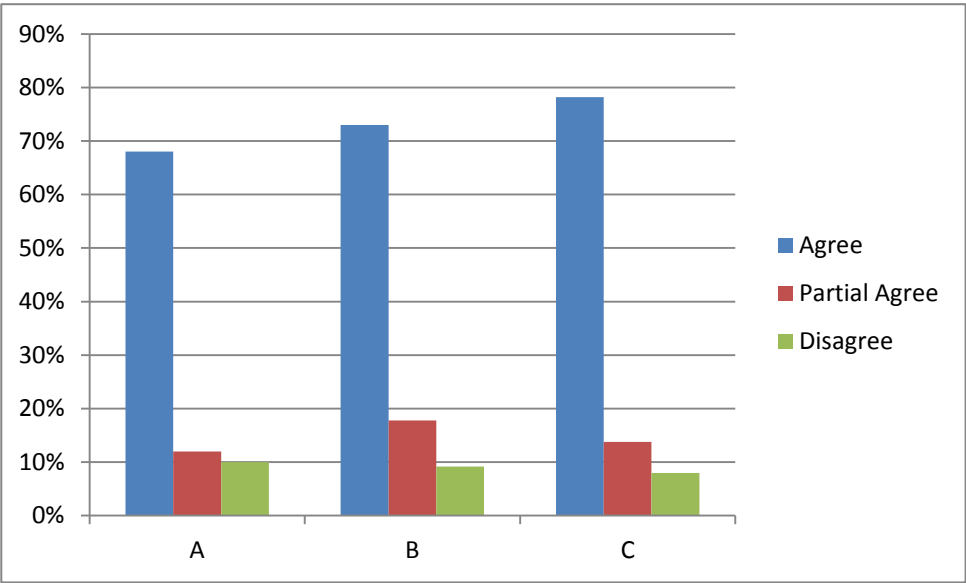


Figure 28. Environmental Concern

The bars are categories under penalties on environmental degradation, environmental promotion and benefit from environmental effect. Almost the 80% percent of the respondent agreed on the statement of instituting environment laws and fines against polluted industries, they further agreed on environmental clean awareness and benefit from environments disturbances. This indicates the good use of environmental consent model in the survey.

10.1.10 The affected ways of Pollution

The practice of environmental pollution could result in numerous diseases. The environment is polluted through three medium .It will be polluted through the air, the land and the water. In all these three bounded medium human live or make habit. In the survey the airborne diseases, associated diseases caused by water pollution and other pollution irregularities was assessed. The airborne and water pollution diseases were analyzed as the highest diseases affected by the society and this was breathlessness, skin diseases and eye irritation problem.

The Effects of Pollution

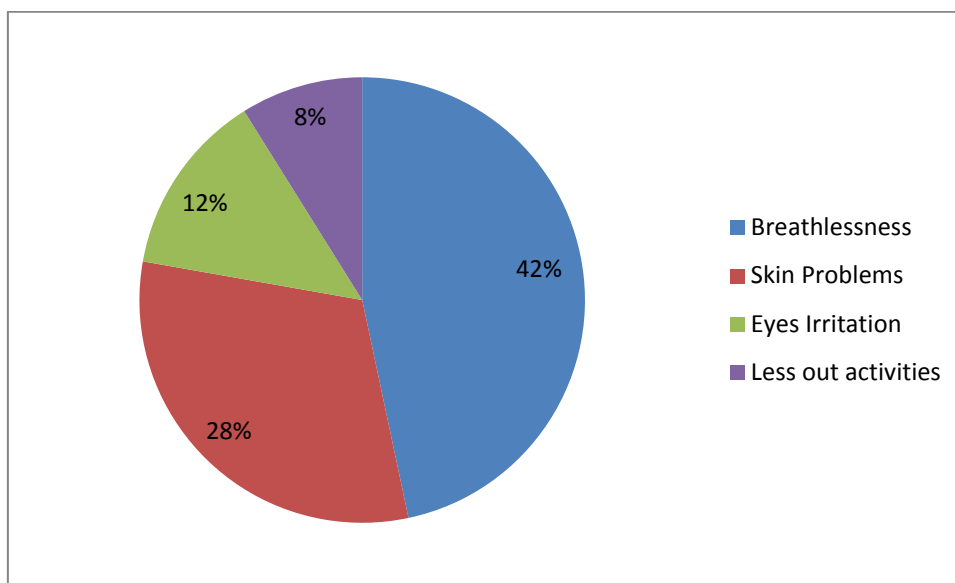


Figure 29. Effects on Pollution

There were 70% mark for industrial activities which the highest among the activities. The Ghana Rubber Estate Limited operates as an industrial as well. The percentile of each activities of the outcome from the survey is indicated on the figure 26

CHAPTER 11 ANALYSIS THE OPINION ON THE PLASTIC AND COCONUT SHELL DEVICE DATA

In this chapter the data was collected in a form of opinion by rating an existence device and a new engineering device which is the designed polypropylene, PP, cup.

11.1. The Opinion Interpretation and Presentation

The chart below indicates the interpretation of the opinion of data collected from the rubber tappers in various zonal premises of the company. The chart is divided into three sections, the plastics cup section, the coconut shell section and no opinion section.

Plastics Cup and Coconut shell

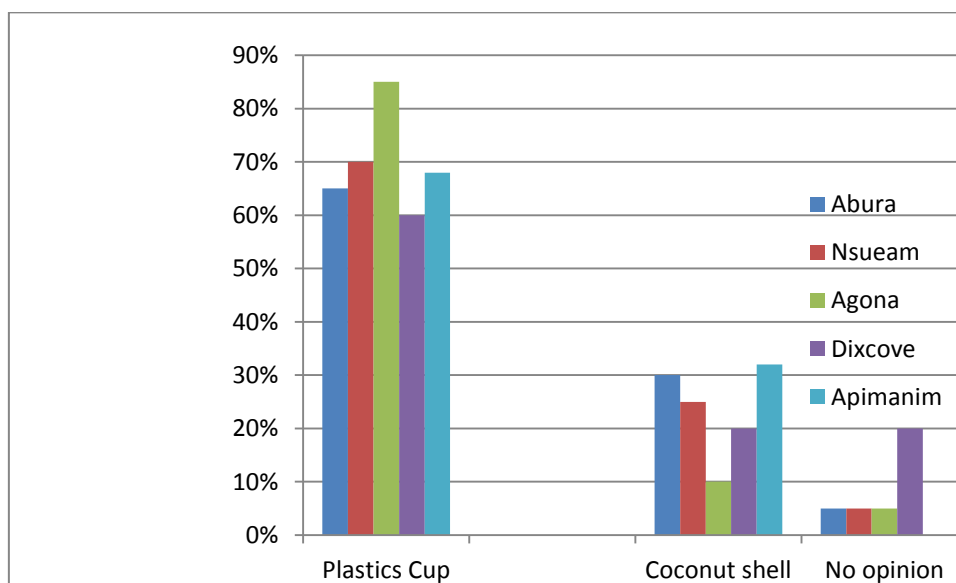


Figure 29 Opinions on the Device

In the section of each chart there were five divisional cities. In the plastics cup section all the zonal representatives commented or rated above 50% percent on their opinion of replacing the plastics cup as device for collecting or harvesting latex than the coconut shell. The other section, the coconut shell and the no opinion section none of the workers rated their opinion above even forty percent. This clarifies the plastics cup is a suitable device for rubber tappers for latex collection. The cup was rated as suitable material because of the heat thermal properties of Polypropylene.

11.2. The Health Information.

Information gathered from the Ahanta West Health Directorate was analyzed into group of diseases. There was three years steady data monitor on patience records and cases reported annually. The figure 30. Represent the increase of diseases in the city.

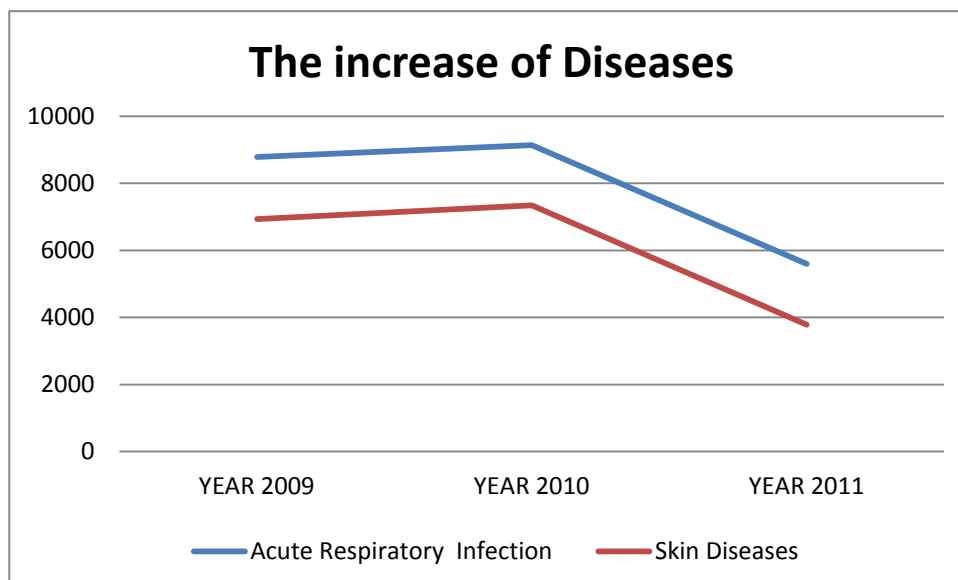


Figure 30. Increases of Diseases

The diseases recorded are environmental Pollution diseases. The chart represents the increase of cases and diseases annually. The last year 2011, the low level of diseases recorded could be the low production at Ghana Rubber Estate Limited. In the research the highest recorded diseases was malaria but due to the ethics of the ministry, the values on malaria are highly confidential to be published. The number keeps on increasing as acute respiratory infection and skin diseases increased.

11.3 Interview and Discussion Information Analysis

In the discussion, the water and sanitation officer expressed a concern about the water pollution. He points out the activities and industries which pollute the environment. The rubber processing was one of the activities that pollutes the environment by channeling solid waste into water bodies and that could promote malaria. On the other hand, the chemical engineer grouped the company as agriculture business industrial. He figures out the chemicals used by the company which serve as toxic to the environment. Rubber processing stages were outlined as one of the activities that pollute the environment. In the coagulation stage, the nursery sprays and rubber tapping. The environmental officer responds towards the environmental condition of the city with negative comments.

CHAPTER 12

Chapter 12. 1 The Result

According to the data collected from the health directorate on figure 30, the number of diseases recorded in the year 2011 on the line chart declined, this resulted inefficient of production by the Ghana Rubber Estate Limited in that year. The ideology behind the statement was that if there was efficient production, there will be increased of chemicals imposed into the atmosphere by polluting the air quality This will resolved in airborne diseases which will increased the acute respiratory infection records on that year and other hand, there will be more raw material used for processing . This increased of raw material which is not treated well will pollute the water bodies. The practice of polluting the water bodies will have effect on the species and microorganism form part of eco system. The habitant forming the ecosystem loses their life then the environment is threatened by that activity. Furthermore, the plastics cup which will substitute the coconut shell for the purpose of latex collection to avoid mishandling of raw material resulted as a device for protecting the environment through avoiding solid waste disposal and toxic compounds like cyanide getting in contact with land so that the soil nutrient will be infertile. The Ghana Rubber Estate which was recorded as the highest pollution company according to the survey. The interpretation of the data has a great contribution on the work. The data computed Ghana Rubber Estate Limited activities as the away of threatening the environment.

12.2 Discussion

The research question of the thesis was generally assigned to the environmental impact as a result of processing rubber. In the research land destruction by rubber crumbs and the chemical effect during processing was essential research problem which were investigated. The processes of harvesting rubber or tapping rubber have a great influence on the environment. The rubber crumb can affects the land by releasing the cyanide compound which is toxic to the environment. The cyanide can destroy the soil quality or the nutrient level of the land, when soil loses nutrients, resolved into low productivity of

farm input. In low productivity of farm input, promote food drought and this will have effect on the social economic life of the people. The releases of industrial liquids waste such as cleaning solvents and other binding agent after production. The protection of equipment's and devices for high performance affects the environment. In addition the preservation of raw material during coagulation processes, the use of formic acid also pollute the environment. The answer the question of the act of toxic released into the environments. The scope of the thesis was further investigated the procedure to utilized scientific approach of harvesting the rubber, which is term as tapping. The idea of galvanizing the knife gauge, using single base V system and herring bone system were the scientific approached advice for rubber tapping. The main objective of the thesis work was to control the environmental pollution as result of rubber processing and also optimized the profit cost of the company as result of reducing mishandling of latex during harvesting. The released of reduction of toxic chemical into the atmosphere can be solved by the following process;

- Fabric filtration process
- Thermal oxidation process
- Wet and dry scrubbing process

The Fabric filtration process is effectively system of controlling environmental pollution problems, which are in gaseous and liquid stream stage. This process is done through physical means by separating the gas or the liquid containing solid particles channel through a porous fabric medium. In the situation of air pollution, the system removes the dry particles from the gaseous emissions. The suspended solids are filter through the filtration processes and in the case of solid waste disposal; the filtration centered on the solids elements and reduce the land fill area. The other processes are very useful but the most effectively processed can resolved the environmental problems at Ghana Rubber Estate Limited are the filtration processes. [34] The efficient handling of latex objective was achieved through replacing plastics cup as device to collect latex. This practice will help the company to save about four drums of fresh latex from all the zonal plantation areas.

CHAPTER13. CONCLUSION.

The idea of understanding natural phenomenon is very challenging and complicated processes, therefore scientists and engineers have designed a tool or developed model for understanding the activities of mankind which have effects on the environment. The designed polypropylene plastics cup helped for solving the mishandling of raw material problem by Ghana Rubber Estate, which also causes financial abasements in the act of using coconut shell as latex collection device. Comparing different data retrieved from health directorate the decreases of diseases during the particular years could be concluded that the reduction of industrial operation which was the cause of the decreases of the problem. In vise-vasa if there was increase of industrial production, the environmental threats will be definitely raises or increased. The analysis obtained from the interviews and discussion the highest diseases of the district are malaria. The malaria diseases comes as result of dirty environment and polluted water bodies which will breads mosquito being the agents of malaria. In all I could conclude that the rubber activities have effect on the society and can threats the environment based on the result analysis through the data collection.

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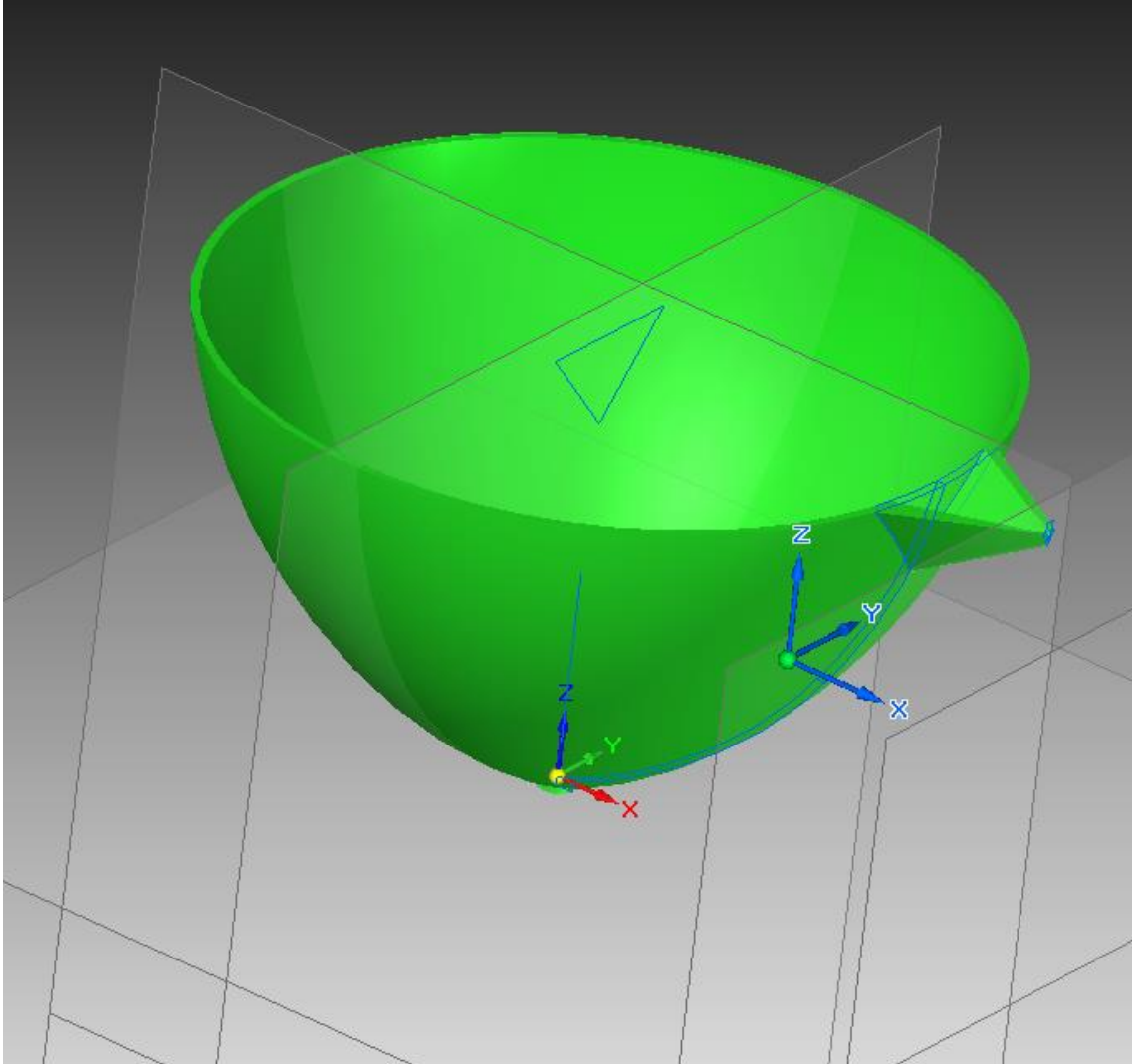
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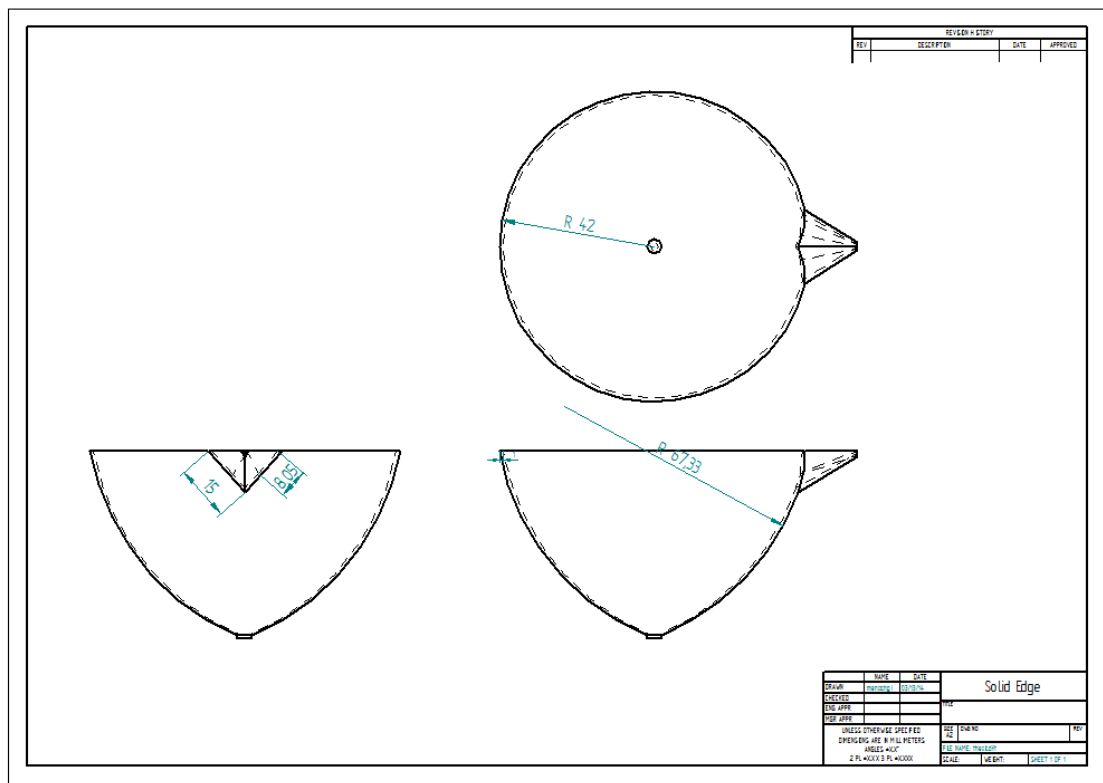
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APPENDIX



Appendix (1) The Solid Modelling Designed Cup



Appendix (2). The drafted part of the plastic cup.



ENVIRONMENTAL THREATS DURING RUBBER PROCESSING QUESTIONNAIRE FOR DEGREE DISERTATION AT ARCADA UNIVERSITY OF APPLIED SCIENCE

1 Please tick your age rage

- ☐ Below 30 ☐ 31 t- 35 ☐ 36 to 40 ☐ 41-45 ☐ 46-50

2 Where do you live and your municipal of residence? (Please provide city name & District)

3Sex ☒ Male ☐ Female

4. What is your occupation? Please select your sector

- ☐ Student
☐ Employed –Government
☐ Employed –Academe
☐ Employed- Private Sector

Other (Please specify).....

5. Does pollution worries you?

..... Very Much MuchNot Much Not at all

6. How will you rate the air quality of the city now and the at least the last 3 years?

..... Much better Little better the samemuch worse

7. Please rank your water quality level from 1 as the lowest and 5 as highest ;
.....

8. What is your main source of water supply in your area? Tick appropriate and All answers are applicable

- ☐ Pipe bone water
- ☐ Hand Dug well
- ☐ Stream
- ☐ Rainfal

9. What do you think are the main causes of pollution in your city

- ❖ Industrial Sources/ Manufacturing facilities
- ❖ Population growth
- ❖ Waste disposal
- ❖ Smoking

10. What extent does the air pollution and water pollution affect you

(a).Not affected at all (b).Affected a little (c) Affected a little (d)Very much affected

11. In which of the following ways are you affected? Please select all are applicable

----- Finding difficult to do outdoor activities

----- Irritation to Eyes /Noise and throats

----- Breathlessness and Skin problems

----- Poor Visibility

12 In which of the following companies do you think are the main agents of land pollution?

(a) INTEX (b) NORPALM (c) DEPAUL (d) GREL

13. In which ways do you think they pollute the environment?

- ☐ Waste Disposal
- ☐ Release of Hazardous chemicals
- ☐ Changes of Vehicles
- ☐ Raw material Processing

14. How will you express your views on this statement?

Strongly agree Agree Disagree Strongly Disagree

Pollution companies be given fines

The improvements of the environment must be a major concern for all nationals

Industries should switch to cleaner processes even if it cost expensive

There should be environmental awareness programs to promote cleaner environments

THANK YOU FOR YOUR TIME