



RECYCLING OF PLASTICS WASTE IN GHANA; A WAY TO REDUCE ENVIRONMENTAL PROBLEMS/POLLUTIONS

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<p>Abstract:</p> <p>Solid wastes management has become a major concern in most countries around the world and Ghana is no exception. The problem of solid wastes especially Plastic wastes in Ghana keep on increasing as the amount of plastic wastes generated in daily basis is very alarming and these plastic wastes litter the environment.</p> <p>In Ghana, the populace has not appreciated the danger that plastic wastes have on the environment, animals and humans. They are not aware that plastic is not biodegradable and it takes very long years to degrade. As a result, plastic wastes make our environment filthy, chokes our drainage systems (gutters) and breeding grounds for mosquitoes resulting in bad smell from choked gutters and diseases such as malaria and cholera from mosquitoes and flies respectively.</p> <p>Landfilling of solid wastes which includes plastics is the common way of managing solid wastes in Ghana, which also comes with some problems in a long round. Although there are other ways of managing wastes but the only best, effective and economic way of managing plastic wastes by mechanical recycling. Using mechanical recycling to manage plastic wastes would create jobs for the people and provide raw materials for plastic manufacturing companies as recycled granules.</p> <p>The information used in writing this thesis work was gathered through observation by the author and also from the textbooks and other sources in accomplishing the tasks. The recommendations from this thesis work would be helpful in management of plastic wastes in Ghana if implemented in the future.</p>	
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FOREWORD

I am very appreciative of the help, support and guidance given to me by my supervisor, Mariann Holmberg to the completion of this thesis work.

I thank all those who help me in one way or the other throughout my studies in Arcada University of Applied Sciences, especially Mr. Mathew Vihtonen (Plastics Technology Programme Director).

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Lastly my sincere regards to all my friends in Finland and back home in Ghana.

1 INTRODUCTION

The world has been facing the environmental waste problems and Ghana is no exception.

Ghana also faces the problem of its own for the past years especially solid waste. For more than two decades, the amount of plastic waste littering the streets of Ghana has been a crucial environmental problem. There is no a proper way of collecting plastic waste and the people are not educated as to the problems of plastic waste.

Whenever anyone wants water to drink, they buy the sachet water, even for their homes. After they drink the water they drop the sachet in the streets from cars, buses and so on. The plastic waste dumped in the streets find their way in blocking drains, which can cause flooding and other plastic waste makes into the water bodies with unsightly tangles of plastic waste.

The plastic waste generated throughout the Ghana brings to the table how to effectively manage these plastic wastes to save the environment from its already existing problems. The problem of organic solid wastes management is not big issue as compare to plastic wastes since organic solid waste is biodegradable.

However, the non-biodegradable nature of plastic waste poses a big problem since the plastic waste can stay in the environment for a quiet period of time causing all sorts of problems.

The most common methods of solid waste disposal in Ghana are through the combustion and land filling. In the case of Plastic waste disposal, burning of the plastic waste does not only get rid of it but produces carbon dioxide which is the major contributor of global warming. The non-biodegradable nature of the plastic waste, burying them in the ground is the appropriate environmental and economical way to dispose plastic waste.

The way forward for plastic waste disposal is through recycling. Recycling of plastic Waste will bring numerous benefits to Ghana. Recycling of plastic waste is environmental friendly as compared to the other ways to dispose plastic waste.

1.1 Objectives

In writing the thesis the following objectives were set up to guide the author;

1. Identify the disposal and management of plastics waste
2. Identify the types of plastics materials in the waste
3. Design a management system for collecting and sorting of plastic waste
4. Find out the effect plastic brings to the environment
5. Identify the recycling processes of plastic waste
6. Find out the benefit of recycling plastic waste

1.2 Literature Sources

In gathering information, quantitative and qualitative research methods were used to gather information and data when writing this thesis.

The quantitative research method here focuses on the numerical data which will be collected from the waste management organisation or agencies or departments.

The qualitative research method was also focused on additional information and data such as literature reviews, photo taking, observations, case study, internet sources and interviews.

1.3 Limitations of the study

In gathering data for the thesis work is the biggest problem that the writer faces. The Writer could not get documented data from the waste management agencies because they thought the writer may use the data to tarnish the image of the country in return for monetary reward in Europe in the expense of the country. They said, people come for data with the mind of helping them to solve to the problem but the end is other way round. Also, the writer was not able go to many place of study due to lack of funds. The cost of traveling to Ghana and staying there in order to gather data involves a lot. Again, the author was forced to use observation, photo taking, previous work and literature on internet for the thesis work. The author was not able to get feedback from the question-

naire to respondents and the people were demanding money before answering the questionnaires and this method was left out of the work due to lack of funds to pay for answers.

2 PLASTICS AND PLASTIC WASTES

This chapter would discuss about what are plastics and the wastes from plastics.

2.1 History of Plastics

History has it that, the development of plastics is regarded as one of the major technical achievement of the twentieth century by mankind.

Since, the development of the plastic, it has been considered as the cheapest materials used in place of other materials such as metal, wood and glass. The quest for plastic products in our everyday life necessitated for new development to improve the quality and the strength of plastic. As the plastic material have some unique properties comparable to other materials in regards to ability of forming into any desirable shapes, resistance to moisture, resistance to tensile stress etc [1]

The discovery of plastic started long ago. It was in the late 1850s when the first synthetic plastic was made by an English inventor called Alexander Parkesine. This achievement was showcased in 1862 at Great International Exhibition in London. It was named after Parkesine and this organic material was obtained from cellulose. Alexander Parkesine observed that when the material was heated and cooled down it retained its shape.

Between 1930-1934, witness the massive development of the most common thermoplastics used today by manufacturing industries. These common thermoplastics for example are polystyrene, polyvinyl chloride, polyolefins and polymethyl methacrylate. The development of plastics did not ceased at that time rather lead to continuous research into plastics till date. [2]

2.2 What are Plastics

Plastics are synthetic or artificial materials made from the used of crude oil and natural gas as the raw material. The raw material contains polymer molecules that are divided into simple individual chemical constituents of a polymer. Plastics consist of several monomers that are linked together in a chain-like form. Plastic material can exist as linear or branched polymers. Plastics are produced by a process of joining one or more monomers such as ethylene, styrene vinyl chloride together and this is called polymerisation. In the process of polymerisation of polymers such as ethylene, vinyl chloride and styrene led to polyethylene(PE), polyvinyl chloride(PVC) and polystyrene(PS) [3]

There are two ways that plastics can be grouped depending on their chemical and physical properties. Plastic can be either thermosets or thermoplastics. With the thermosets, they are plastic that are harden by chemical cross-linking reaction involving polymer molecules. The chemical properties of thermosets breaks down upon heating and thus weaken the bonds between the polymers molecules. This weaken of the bonds is irreversible.

On the part of thermoplastics, they are softening by heating and harden upon cooling. There are no chemical bondings between the polymer molecules as in the case of thermosets. Thermoplastics take their shape back when heated and allow cooling. Thus the process is reversible. [3]

2.3 Types of Plastics

There several types of plastics been produced by plastics manufacturing companies around the world including the traditional plastics and modified plastics. In the developing countries however, the traditional plastics are manufactured for use. In this study the writer is focusing on the following five plastics, PET, PE, PVC, PS and PP.

These plastics are used in our daily life in ways such as food packing, storage containers, food containers etc. Below is the briefly description of each of the above type of plastics according their properties, process of manufacturing and uses.

2.3.1 Polyethylene

Low density polyethylene (LDPE), Linear Low Density Polyethylene (LLDPE) and High density Polyethylene (HDPE) are the three types of Polyethylene plastic. Polyethylene has a density range of 918-965kg/m³ depending on the type. It is a soft, tough and flexible and transparent material. LDPE is used in the application of making bottles, bowls, buckets, film plastic bags, tubing or pipes, electric or telephone insulators etc. on the part of HDPE, it is slightly tougher and stiffer than LDPE. It is used in manufacturing of dustbins, bottles crates, pipes and fluid containers.

2.3.2 Polystyrene

Polystyrene (PS) is a thermoplastic material that is obtained by polymerisation of monomer styrene extracted as liquid from petroleum. It is a brittle, transparent material and it is solid at room temperature and soften to liquid at temperature above 100^oc. Polystyrene is produced in the form of either as solid or foamed plastic and use in the application such as electrical thermal insulation, window panels, food cutlery, battery case, food box etc. It is resistant to heat, oil, acids, alcohols etc [15]

2.3.3 Polypropylene

Polypropylene (PP) is a thermoplastic material made from monomer propylene and properties such as rigidity, chemical resistance, stiffness and excellent fatigue. In terms of its applications, it is used to make pipes, crates, chairs, tool handles, TV cabinets, machine parts, carpets, bottles etc.

2.3.4 Polyvinyl chloride

One of the most used plastic materials is polyvinyl chloride (PVC). The plasticised and unplasticised are the forms of polyvinylchloride. Polyvinyl chloride has flexibility ri-

gidity, resistance to weathering, hardness, toughness and electrical insulation as its properties depending on the form of polyvinylchloride concern. Polyvinylchloride is used in applications such as floor tiles, raincoats, water pipes, window frames, water hose, gloves, toy balls etc.

2.4 Sources of Plastic Wastes

Plastic has been considered as one the commonly used materials in our daily life due to its unique properties such as light in weight, flexibility and durability. However, it has bad side; the effect of plastic wastes on the environment is a huge problem that people face.

The plastic wastes generation in Ghana comes from different ways or sources such as metropolitan, municipal, district waste, commercial waste and industrial waste.

2.4.1 Metropolitan, Municipal, District waste

In Ghana, the ministry of Local Government and Rural Development (MLGRD) is responsible for managing waste, since it is that government institution which supervises the decentralized of Metropolitan, Municipal and District assemblies (MMDAs). The MMDAs work alongside their private partners such as Zoomlion. They collect the wastes including plastic from residential areas, streets, parks, waste collection points and waste dump site popularly called “Boola”. The manner in which people disposed plastic wastes is worrying. The amount of plastic wastes keeps on increasing due to the increase of population and life style of the people. In Ghana, since the introduction of drinking water packaged in the sachet and bottle termed pure water and the use of plastic as packaging material when you buy a product from the market or shops led to the increase. Once the plastic sachets or bottles are empty of water, they are thrown away into the streets with impunity. According to the estimation that there about 20 million people actively involved in daily activities, out of this population each individual throw out one plastic sachet or bottle, then there would be 20 million of plastic sachets or bottles per day, which is very huge. All these indiscriminating disposal of plastic

wastes find their way into gutters which then block the flow of water whenever it rains which then causes flooding.

2.4.2 Commercial Wastes

Commercial wastes are waste generated by the shops, supermarkets, hotels, restaurants, institutions during their operations. These wastes include some amount of plastic wastes which end up into our environment. There are no well organise way of disposal of solid wastes. People dispose the wastes in their own ways, wherever they find it necessary to dispose them. In some cases, people gather the plastics waste and set fire on the waste to burn the plastic waste which they pollute the air.

2.4.3 Industrial Wastes

These are wastes generated by the manufacturing, packaging, and construction and assembling companies. For instance, the scraps from plastics companies, plastics used as packaging or wrapping of parts in automobile and construction industries. All these plastic wastes from institutions contribute to waste problem in Ghana.

2.5 Hazards of Plastic Wastes

The plastic waste is one of the wastes that have negative impact to the environment. The plastic wastes affect the environment in three ways; air, land and water pollutions.

2.5.1 Land

From figures 1 and 2, shows Plastic wastes litter the land and find their way in blocking the gutters and drains. The blocking of the gutters and drains by plastic wastes causes flooding whenever it rains, because the rain water cannot get access to flow and the stagnation of the rain water created by plastic wastes provide breeding place for mosquitoes, which later cause malaria to the people.

The plastic wastes do not affect only the people but also animals such as sheep, goats, cows, fowls etc as seen in figure 2. These animals die through the taking in of plastic waste along as they graze the field. Again, when plastic waste litter the farm lands, they

entangle the crops preventing them to grow and also the plastic waste cover the soil then preventing air penetration into the soil, then killing the soil organisms that help to till the farmlands.



Figure 1 Plastic wastes, Kumasi tanoso

source: Author



Figure 2 Cow feeding on plastic wastes

Source: www.advocacy.britannica.com



Figure 3 Plastic litter (Image: Sarah Watson, PACE)

2.5.2 Water

Plastic wastes find their way into the water bodies thus polluting the water. The plastics then float on the surface of the water bodies, thus preventing direct sunlight for the water organisms. Water animals are killed by plastic waste that finds their way in water bodies as they mistakenly eat plastics as food. Since plastics are indigestive material and stay inside them, then cause pains and this leads to death. After the decay of the animal, the ingested plastic is freed back to the environment again to continue causing problems.

2.5.3 Air

Plastic wastes are non-degradable substances and made of toxic chemicals that pollute the air. Poisonous substances such as toxins are release to the air when plastic wastes are burned are harmful and these causes respiratory problems and cancer as they are inhaled. [19]

From the fig 4 below, shows the smoke that comes out as a results of burning the solid wastes including plastics produce carbon monoxide (CO), carbon dioxide (CO₂) and so on which affect the environment in general.



Figure 4 wastes dumping site, Kumasi Tanoso

Source: Author

3 RECYCLING AND RECOVERY PROCESSES OF PLASTIC WASTES

In the quest of finding ways to properly manage plastic waste aside from landfilling and incinerating, then recycling has come to the table.

The plastic recycling process is referred to as the process of collecting plastic waste materials and then separating or sorting and processing them into reusable material again [4].

In recycling of plastic wastes, certain stages or steps such as collection, sorting, chipping, washing or cleaning and pelleting are needed to achieve an efficient and cost-effective process.

3.1 Collection of plastics

Effective collection of plastic waste can be done by identifying the sources of plastic wastes, the contributors of the plastic wastes. There are two main sources in which plastic wastes find their way to pollute the environment and these are post-consumer plastics (used by people) and post-industrial plastics (from the industries).

Plastic wastes can be collected for recycling from people in residential areas by putting recycling plastic waste bins in vantage places for easy collection later and also collecting from the roadside. With industrial plastic wastes, these can be collected from the industry, the defects of plastic products and wastes. [Selinger, Ben; *Chemistry in the Marketplace (3rd edition)*; Harcourt Brace Jovanovich; 1986]

3.2 Sorting








After collecting the plastic wastes from the various collection points and bringing them to the recycling site, the next action is sorting. The plastic wastes are put on a conveyor and here the plastics are separated from other wastes such as metals, wood. Plastic wastes are sorted into different types of plastic by using recycling codes for plastics, for instance, code 3 for PVC (polyvinyl chloride). This can be done by training the workers to identify the different type by using the code, texture and appearance. Sorting of plastic waste can be done in either manual sorting or mechanical sorting.

In manual sorting, it involves the use of hands to separate the plastics waste into different plastics or separate the metals, wood etc from the in the case of mixed waste recycling.

With the mechanical or compressed air sorting, the sorting is done by automatic separation by using magnet to attract metals and also blow air across the falling plastics to separate wastes into different compartments depending on their weight [5]

Table 1 plastic recycling codes

Source: www.plastics.americanchemistry.com (19.01.2012 viewed)

Plastic Codes	Name of plastics	Plastic Codes	Name of plastics
	Polyethylene Terephthalate		Polypropylene
	High Density Polyethylene		Polystyrene
	Polyvinyl chloride		Other plastic (example polycarbonate, PC)
	Low Density Polyethylene		

3.3 Chipping or shredding

The sorted plastic waste is then sent to the chipper or the shredder to be cut into small plastic flakes. In the case of big plastic bottles, it is important to cut the bottles into small sizes before feeding them into the chipper or the shredder. This process is known as the size reduction. The chipper is incorporated with rotating cutting blade or cutter in a cylinder. From the figure 5 below, the plastic waste s are feed into the chipper and the

rotary blade inside the chipper then cut the plastic into the required small pieces (flakes) and these go through a passage with small holes into flakes collector(collection bin). The rotary blade of the chipper or shredder can be powered by electric motor or mechanical engine. The rotary blade is connected to the electric motor or the mechanical engine by pulley belt with the pulleys of both rotary blade and electric motor or engine. Through the transmission of power between the two, the blade of the chipper rotates then initiates the cutting the process. The small pieces of plastic that comes out during the process are collected as seen in figure 4 below. The product is either washed if not washed prior to the cutting and pack into bags for selling the plastic plant or the flakes then go into another process of extrusion into granules.



Figure 5 plastic chipper/ shredder

Source: Photo taken from Arcada Plastic Laboratory by author



Figure 6 Plastic flakes

Source: Arcada Plastic laboratory, photo taken by author

3.4 Washing

In recycling of plastic wastes, one critical thing that must be done is washing of the recycled plastic flakes or plastic waste materials before or after the process. The washing of the plastic wastes can be done either manually or mechanically operated mechanism in a well-constructed washing tank, where by the dirty water can be drain out easily. Since the plastic wastes are already contaminated with a lot of dirty such as grease, oil, dust etc, it is important to use the required surfactants (detergents) and water (cold or hot) to loosen and remove the contaminates from the plastic materials.

With the manual washing,

3.5 Pelletizing

The plastic flakes (figure 6) are feed into an extruder when then melt the flakes. The melted flakes are extruded out of the extruder through a die of small holes.

The plastic flakes in the hopper of the extruder travels by the gravity into the feed rod and drops onto the rotating screw. The rotation of the screw conveys the plastic forward through the heating barrel. As the plastic is convey forward along the screw the channel depth decreases forcing the plastic to a smaller area. The plastic is melted by heat generated from the friction by the combination of compression and screw rotation and the heat from the barrel system. The plastic is well mixed when the melted plastic reaches the end of the screw. At this point the screw acts as pump to force the melted plastic out of the screw through the die and the melted plastic comes out as strands. The hot plastic strands pass through a water tank to cool and solidify the strands. As the plastic strands are cooled and solidifies, strands are conveyed towards a pelletiser which then cut the plastic strands into pellets with in-built cutting blade.[6]

4 METHODS OF RECYCLING PLASTIC WASTES

The recycling of plastic wastes simply means turning the plastics wastes into a meaningful used instead of becoming a problem to the environment. As plastic wastes have become environmental problem that affect developing and developed countries. In solving the plastic wastes, there is the need design and develop cost effective and efficient methods of recycling the plastic waste materials in order to improve the environment and create employment. The plastic waste materials could be recycled through the mechanical recycling, chemical or feed-stock recycling and energy recovering.

4.1 Mechanical Recycling

Mechanical recycling is regarded as the best technology for recycling of conventional plastic waste materials into new raw materials without the basic structure been changed. The mechanical recycling involves crushing, washing and sorting operations and it is use for all types of plastic waste materials. This process involves the assembly of mechanical products which includes driven electrical motor, pulley, cutter and others. The collected, sorted and clean plastic waste materials are put in the shredder or chipper to grind into the smaller pieces called flakes. The flakes are then feed to the extruder machine through the hopper. The extruder is incorporated with rotating single or double screw in heating barrel. When flakes are melted in the heated barrel and force out through a die by the rotation of the screw. The melted flakes come out as hot strands and passes through water to cool, which then are cut into pellets or granules by cutter. The finished products (recycled granules) are put into bags for prospective buyers or plastics manufacturing companies.

The mechanical way of recycling plastic waste materials is quiet simply to employ in Ghana, since the mechanism is easy. For instead, in Gratis Foundation Bolga, where the writer had worked as a national service personnel design and manufacture rice tresher which uses the similar mechanisms.

4.2 Feedstock or chemical recycling

Here the plastic waste materials are broken down into smaller chemical form by chemical process and reuse to produce raw material for manufacturing plastic products or different kinds of products. The feedstock recycling is done by decomposition of the plastic waste materials aided by the presence of heat, chemical agents and other catalysts in order to turn the plastic waste materials as source of hydrocarbon chemicals or fuels. [7].

In feedstock feeding, only specific plastic waste materials are used in this process such as PET, nylon etc. It has limitation of not recycling mixed plastic waste material but only separate plastic waste. There are several separation methods that need be carried out in order to completely recycle the plastic waste materials by feedstock recycling. The separation methods must be followed systemically and these are gasification, thermal

treatment, hydrogenation, catalytic cracking and chemical depolymerisation as in the figure 7 below. [8]

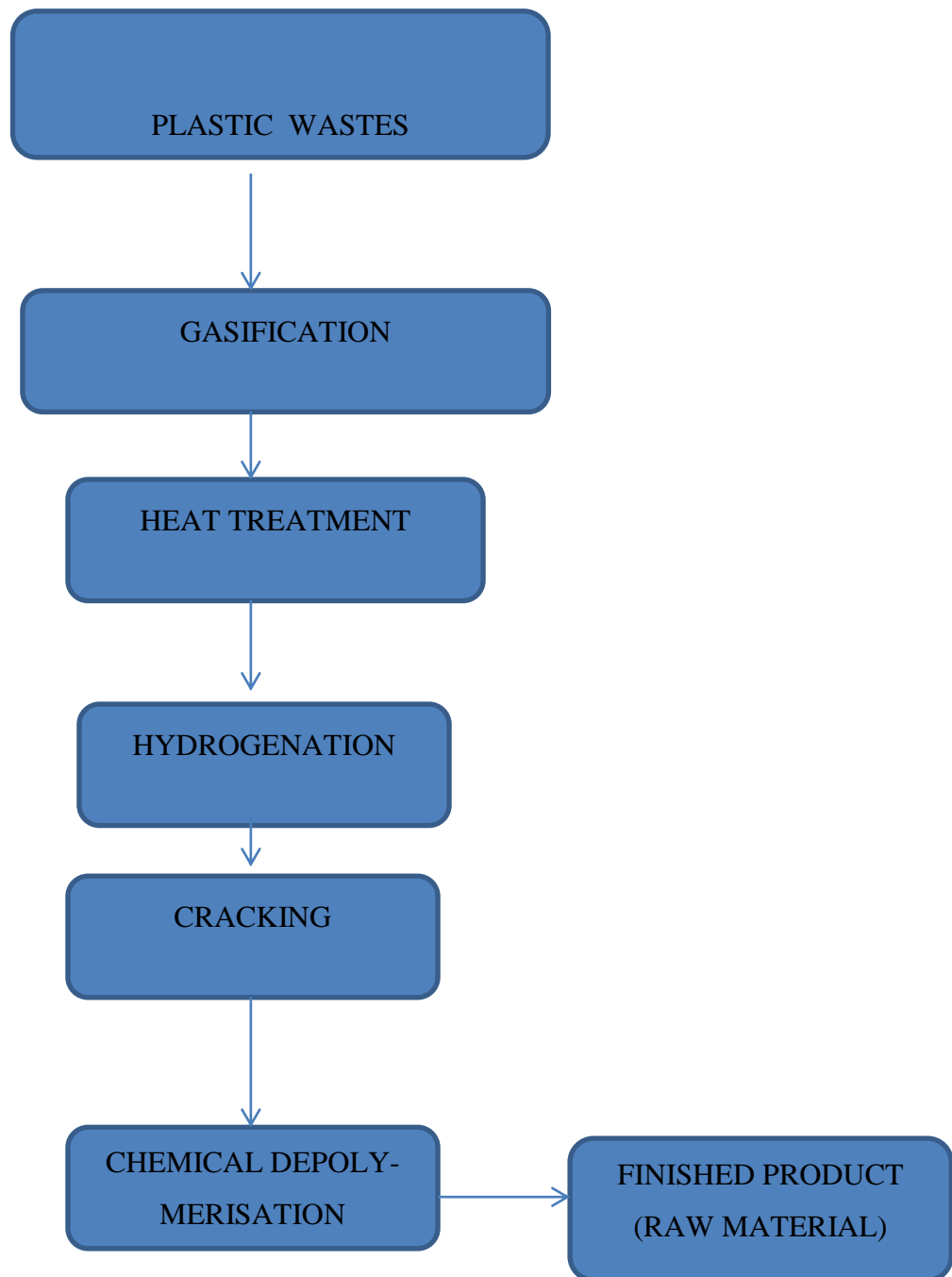


Figure 7 Feedstock Recycling processes [8]

4.3 Incineration of plastic wastes

Plastics are made from crude oil and since crude oil contains hydrocarbons which have high combustion rate resulting in production of energy for work output. Incineration is the burning organic wastes under controlled conditions. So combustion of plastic wastes produces heat energy used to generate power for other works. It is important to note that though it produce energy but it has environment effect if not properly controlled since produces smoke and ashes which are harmful to living organisms.

5 MANUFACTURING PROCESS OF PLASTICS

In plastic industry, the products are produce by different manufacturing process depending on the type of product. Some of the manufacturing processes used in plastic industry to produce plastic parts are: injection moulding process, Extrusion process, Blow moulding process, injection blow moulding process, Extrusion blow moulding process, Stretch blow moulding process and so on.

5.1 Injection Moulding

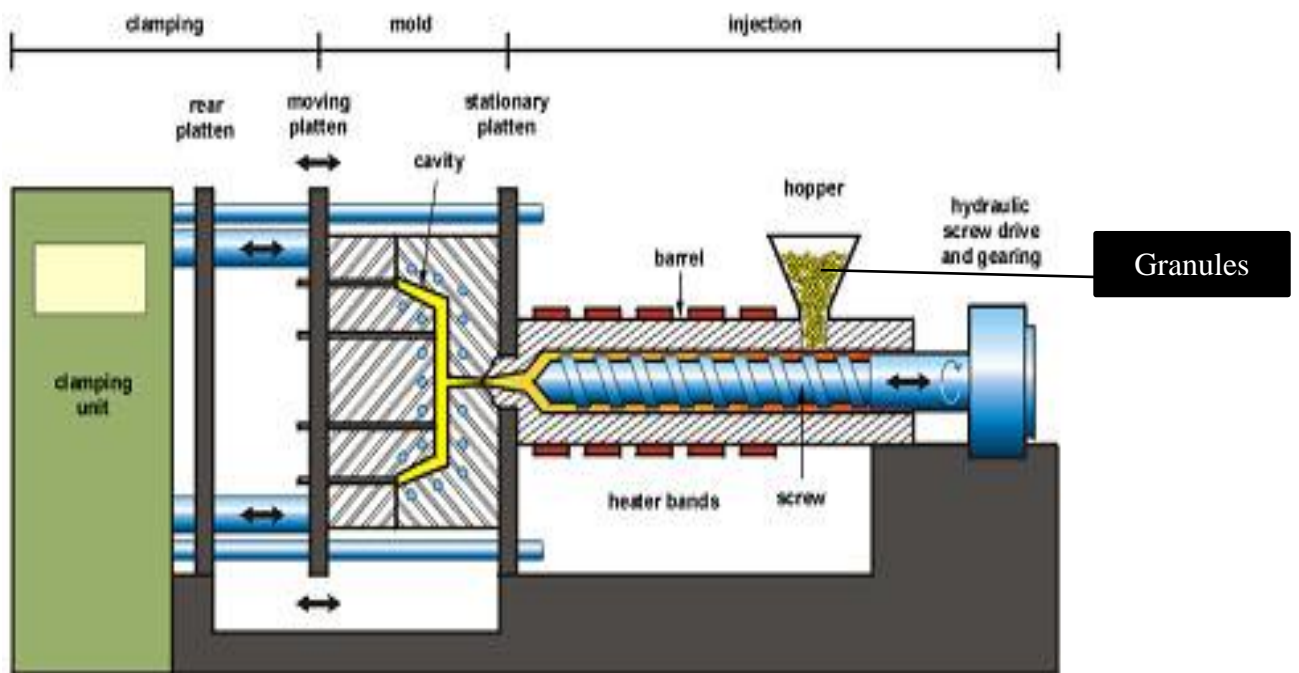


Figure 8 Schematic of Single Screw Injection Moulding Machine

Source: www.idsa-mp.org

Injection moulding process is one of the most important manufacturing processes in plastics industry. It is used to produce wide range of product from simple to complex plastic products by heating plastic granules to soften or melt the plastics in a barrel and then forced out into a mould under high pressure. Injection moulding machine is the equipment used in injection moulding and it is comprises of several units that aid in the whole operations. The units of the injection moulding machine comprises of the injection unit, clamping unit, control system, tempering devices for the mould and mould cavity which is usually made from steel or aluminium. [9]

The operation of the injection moulding machine involves the plastic granules (raw materials) been put into the machine through the hopper as in figure 8 above. Depending on the type of injection moulding machine concern, it normally consists of a cylinder barrel equipped with external heaters to the granules, the screw (single or double).

The screw(s) is /are driven by motor that rotates the screw(s). The molten granules travel along the length of the screw(s) to the end or tip of the screw(s) inside the barrel by the rotation of the screw(s) which results in tearing or shearing action on the plastic granules to melt. As the screw(s) continue(s) to rotate, thus the volume of molten granules increases at the tip of the screw(s) causes high pressure build up. This high pressure aids the screw(s) to push forward to force or inject the molten plastics into mould cavity through injection nozzle. The molten plastics takes the shape of the cavity as the pressure is maintained for the product to solidifies and then the mould is open to remove the final product. [10]

With injection moulding process, both thermoplastics and thermosets materials are used in manufacturing various products, but mostly thermoplastic materials such as polystyrene, polypropylene, polyethylene are used. The process is simple, fast and does not need any further post moulding process. Products made from this manufacturing process include;

Litter bins

Bottles caps/lids

Washing bowls

Phone cases

Drinking cups

Electrical appliances case

DVDs/ CDs

Plastic chairs

Plastic buckets etc

5.2 Extrusion moulding process

In plastic manufacturing process, extrusion is a process that involves continuous drawing, forcing or pushing the molten plastics in a heated barrel through one or more dies by the turning screw aided with pressure to produce the required shape. The extruded product is cooled with the help of either air or water in a drum to solidify and then cut into units. The extruded end product could be solid or hollow form such as pipes, plastic profiles, plastic films and sheets. [10]

A single screw extruder is shown in figure 9, it comprises of one or more screws, barrel or cylinder. The extruder machine operates on the working principles as injection moulding machine discussed in 5.1

Extrusion process is the best plastic manufacturing process used in turning recycled plastic flakes into pellets for making other plastic products.

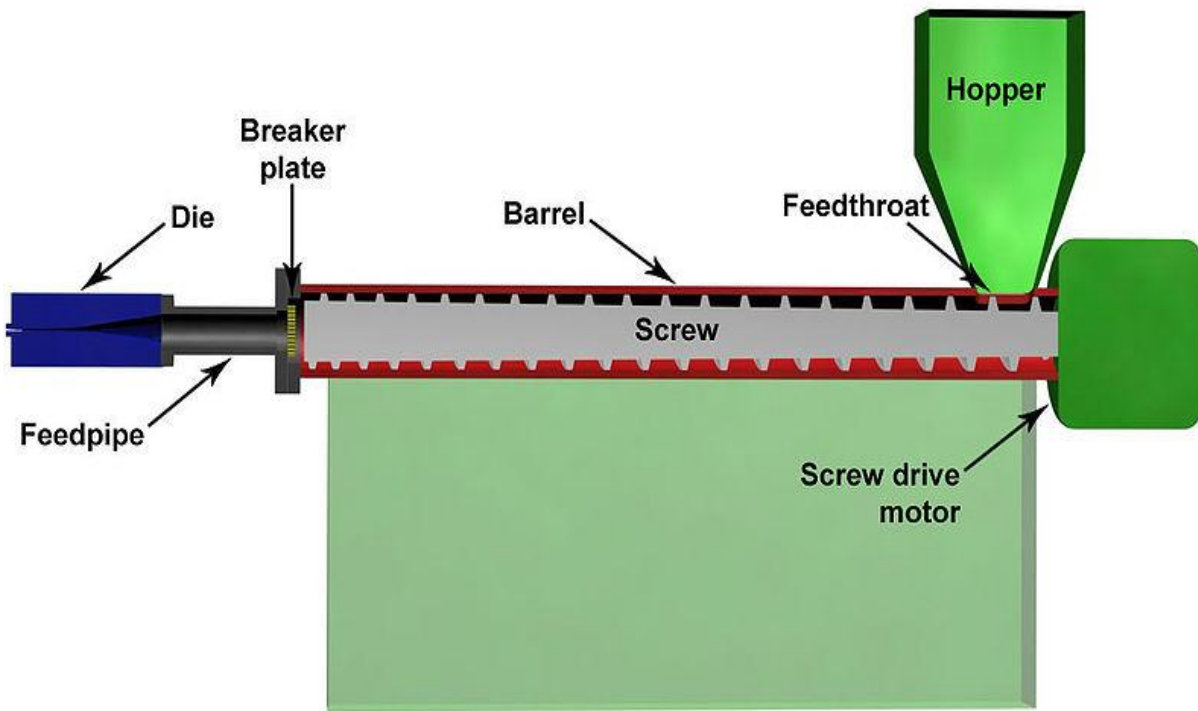


Figure 9 A single screw extruder machine

Source: www.wikipedia.org (28.3.2012)

5.3 Blow moulding

Blow moulding process is an engineering process used in manufacturing hollow products such as bottles which uses air in the process. In blow moulding process, the molten plastic (parison) is extruded through a die into open mould and the mould is then closed around the extrudate (parison). As the parison is securely placed inside the mould air is then inflated into the parison through a design hole in the mould to expand or stretch the parison to take the shape of the cavity of the mould. The shape formed in the mould is then allowed to solidify and the mould opens into two halves to eject the final product

out of the mould. In blow moulding process, parison can be formed by injection moulding process and extrusion moulding process.

5.3.1 Injection blow moulding

From figure 10, the molten plastic (parison) is first injected into a mould with two halves closed together having a cavity. The injected parison is formed around a blow core rod in a heated preform mould. The formed parison with a hollow formed neck is transferred to a blow mould while still in soften state. In the blow mould, a pressurised air is inflated through a hole in the blow rod to expand the parison to take shape of the cavity of the mould. After the parison had taken the shape, it cools by the walls of the mould to solidify and the mould opens to remove the product as shown in figure 10 below.

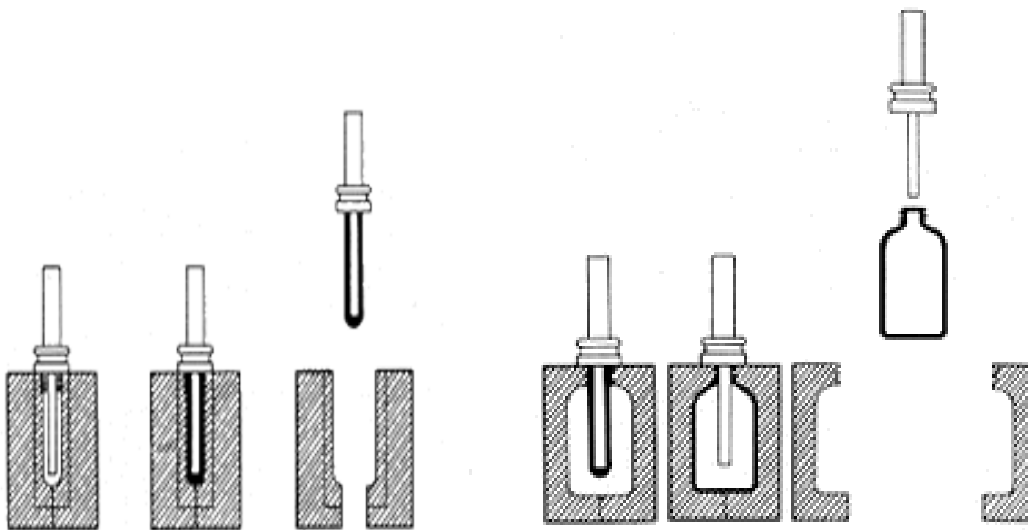


Figure 10 injection blow moulding process

Source: www.plastics.inwiki.org

5.3.2 Extrusion blow Moulding

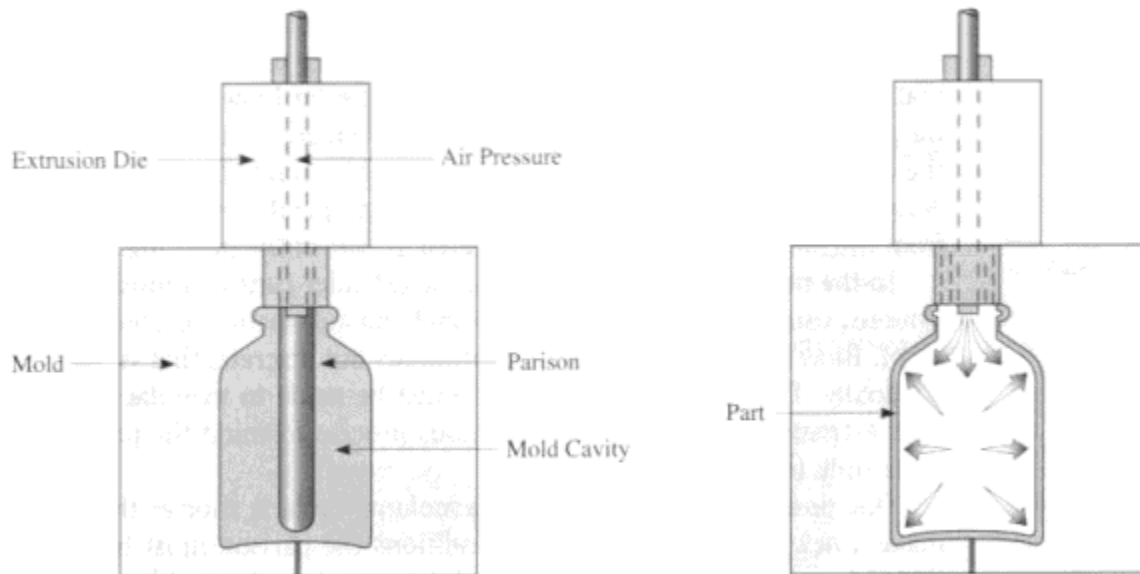


Figure 11 Extrusion blow moulding process

Source: www.engr.bd.psu.edu

Extrusion blow moulding process is also used in the production of hollow plastic objects or parts. It uses the extruder machine in the process of forming the parison. The molten plastic is extruded in the form of a tube to a certain length downwards between the two halves of an open mould. After the extrusion is done, the mould closes to trap and seal the parison inside the mould. At this stage, compressed air is introduced to the parison through a blow pin to inflate the parison to cause the expansion of the parison to take the shape of the mould cavity. After product is cool and solidifies in the mould, the mould opens to eject the product as shown in figure 11 above.

6 BENEFITS AND SHORT FALLS OF RECYCLED PLASTICS

Recycling of plastic wastes in general has some benefits to the country if been done. These benefits can be grouped into social, economic and environmental benefits and are shortly discuss below.

6.1.1 Social benefits

Every society needs to be cleaner and healthier to live in. As plastic wastes that litter the streets and choke gutters which causes breeding grounds for mosquitoes and flies, which then causes malaria and cholera to the people. So recycling of plastic wastes will contribute to reducing or preventing the diseases associated with the plastic wastes. Society with healthy people will contribute to better development; since the people would be able to go on to do their work with any problems.

6.1.2 Environmental benefits

Recycling of plastic wastes protect the environment in a considerable way. Plastic is manufactured from crude oil and as the demand for plastic increases; considerable amount of energy resources is put on drilling and refining the crude oil. The energy used in recycling of plastic waste for reuse is less as compare to that of the energy in the production virgin plastics. In attempt of getting virgin plastics from the crude oil contribute to the emission of carbon dioxide CO₂, sulphur dioxide SO₂ into the atmosphere thus causing global warming. Recycling of plastic wastes for reuse will reduce the dependence on the natural plastic raw material, thus preserve the raw material for long. Recycling plastic waste will reduce the amount of the plastics that litter the gutters and streets. Again recycling of plastic waste will help to keep the water bodies clean, since the wastes in the landfills can leach dangerous chemical into both surface and underground water.

6.1.3 Economic benefits

As the plastic product manufacturing companies depend on the virgin raw material importation from other countries to Ghana, the reuse of recycled plastic pellets would reduce the dependency on the virgin material. The cost of recycled plastic is less cheap than the virgin plastic, therefore reducing the cost purchasing the raw materials.

Recycling of plastic wastes in Ghana would help to create employment for the citizens' right from the collection point to the end product. For instance in Ghana, BLOWPLAST RECYCLING and Poly Group companies buys plastic wastes from people and recycle them for reuse create employment for people to earn an income. Clean environment also

promote tourism since Ghana have a lot of tourist attraction places such as Mole national Park, Lake Bosomtwi, Aburi Gardens etc.

6.2 Products made from Recycled plastics

Recycled plastics are used in manufacturing various products used in our daily lives.

These products include the following;

Sign and information boards,

Garden furniture

Litter bins

Garden Fence

Toys



Figure 12 Way marker post

Source: www.recycledplastic.ie



Figure 13 Garden furniture

Source: www.recycledplastic.ie

6.3 Short falls of Recycling of Plastic Wastes

Recycling of plastic wastes seems to be the best solution for plastic wastes and a way of providing raw materials for the manufacturing companies. However, there are certain needs that plastic recycling industry has to consider when purchasing recycled plastic pellets. These considerations could be the health safety, manufacturing processing and the quality of the recycled product.

The demand of recycled plastics is increasing but there are some factors that go against the product. The manufacturers have to decide whether the recycled plastic is safe for a particular product in terms of health in food packaging, for instance recycled PET cannot be used in food packaging again. Since recycled plastics are gotten from waste that has been contaminated and if not properly sorted and washed well, there would be still some traces of contaminants in the final recycled.

6.4 Results

From the objectives of this thesis work, the following findings came out based on the objectives;

1. Identify the disposal and management of plastic waste.

- That Ghanaians have poor attitude towards waste disposal especially plastic wastes. In Ghana these days drinking water comes in plastic sachets bags and not in bottles normally called “PURE WATER”. After drinking the water the empty sachets are left in the open with the mindset that it is the responsibility of MMDAS to clean the environment especially the wastes.
- It was found that solid wastes were not sorted to separate metals, glass and plastics from each other
- That the only way of disposing the solid wastes were by land filling.
- In most communities in Ghana have a refuse dump usually called “BOOLA” where they dump their wastes and this place is an open area, which is not safe since the wind blows the wastes around. Again the wastes are set on fire when comes huge so as to burn the wastes to reduce the size of the wastes.
- The populace have believed that it is the responsibilities of MMDAS to go around and clean the environment since it is their work.

2. Identify the types of plastic materials in the wastes.

During this thesis work, the following types of plastic materials were found in the wastes generated by the populace:

- Polyethylene (PE)
- Polyvinyl chloride (PVC)
- Polystyrene (PS)
- Polypropylene (PP)
- Polyethylene terephthalate (PET)

3. Design a management system for collecting and sorting of plastic wastes.

The researcher of this thesis proposed the following wastes management system for collecting and sorting plastic wastes

- Provisions of litter boxes and dustbins for plastic wastes only in vantage point in the cities by the cities authorities.
- There should be house to house collection of plastic wastes using push cart or donkey cart by employing or hiring people to do the work to feed the recycling companies. This push cart or donkey can be manufactured locally by Gratis Foundation throughout the country as shown in figure 14 and figure 15 respectively.
- There should be campaign on the damage that plastic wastes littering can do to the environment on both television and radio.
- Wastes Taskforce should be set in all communities to enforce proper disposal of wastes and arrest the culprits to be punished by fine or sentence to prison term for three months to serve as example to others.
- The Metropolitan, Municipal and District Assemblies should at least set up one small plastic recycle Plant since plastic wastes contribute between 60% to 85% of the total wastes in most cities and towns in Ghana.

4. Find out the effect of plastic brings to the environment

- On health grounds, litter plastic wastes are carried into gutters that choke them causing flooding when it rains and also as breeding grounds for mosquitoes and houseflies which then cause's malaria and cholera respectively. In this vein, the government spend huge sum of money to import drugs to deal with the diseases.
- The indiscriminately disposal of wastes makes Ghana to be a filthy country which has some implications on the tourism section since the beaches and parks are full of plastic wastes.
- The burning of the plastic wastes as a way of disposing them produce toxins such as carbon monoxide, carbon dioxide which causes cancer, inhaling and eye problem by smoke that comes out from the burning.

5. Identify the recycling processes of plastic wastes.

The following processes came out for discussions;

- Mechanical recycling
- Feedstock

- Energy recovery and incineration
6. Find out the benefits of recycling plastic wastes.
- That recycling would reduce the amount of plastic wastes on the environment.
 - That recycling would create employment for the populace for collecting the plastic wastes thus bettering the economic status of the populace.
 - Reducing the dependency on the importation of plastic raw materials, since the recycled plastics could be used to feed the plastic manufacturing companies.



Figure 14 Push Cart

Source: www.gratisghana.com



Figure 15 Donkey Cart

Source: www.gratisghana.com

7 CONCLUSIONS AND RECOMMENDATIONS

This chapter would deal with the conclusions and recommendations for the thesis work by the author.

7.1 Conclusions

General wastes generated in Ghana is the sole responsibility of the ministry of Local Government and Rural Development, which includes the supervision of the metropolitan, municipal and District assemblies (MMDAs). The Metropolitan, municipal and District Assemblies are responsible in collecting and disposing of the waste to the landfills. For this reason, it is important for the regulatory authorities in charge of waste management in Ghana to support the establishment of recycling plants throughout the country. The possibilities of recycling as discussed in this thesis work especially mechanical recycling should be integral part of the Metropolitan, Municipal and District level waste management, since other possibilities are more advance technology. To achieve the purpose of recycling of plastic waste in the country, the government of Ghana has a major role to play in order to promote the sustainability and progress of recycling in all the metropolitans, municipals and districts in Ghana. It is important to note that, establishment of recycling plants would create employment for the populace to earn an income to support themselves financially, and also the recycled pellets would be used as raw material for plastic companies to reduce the dependency on the importation of virgin pellets.

The government of Ghana should support the Metropolitans, municipalities and district assemblies with logistics and financial support to provide necessary equipment for proper waste management. For instance, the MMDAs should educate the populace on the danger of waste on the environment and also provide waste collection bins and containers at vantage points to enable the populace to appropriately dispose of their waste. For the purpose of recycling, the MMDAs should also educate and encourage the populace on the separation of plastic wastes from other wastes to enable recycling to become easier and cost effective.

7.2 Recommendations

Everybody would want to live in a healthy environment and free of filth. To achieve this, everybody must have environmental consciousness in mind, that littering the environment is a wrong to do but reusing and proper disposal is the key.

In order to curb and minimize the amount of plastic wastes found in the environment and meet the objectives of recycling of plastics the following recommendations would be helpful.

- ❖ The MLGRD should collaborate with the Ministry of Education, Youth and Sports (MOEYS) to educate the school children on the danger of littering the environment and the benefits of clean environment. In this way, it would inculcate and instil some good behaviour in the school children and as they grow with it the better it serves the environment.
- ❖ The MMDAs in various regions should design awareness campaign seminars to educate the populace at the local level and national levels the need to keep the environment clean from wastes. The MMDAs should educate the populace on how to sort various types of wastes for easy final disposal. For instance plastic wastes in one bin and metal or biodegradable waste in different bins. The MMDAs must also enforce environmental by-laws to the letter and to ensure that anyone caught littering the environment is brought to book for others not to follow suit.
- ❖ The Government of Ghana should support the MMDAs to provide waste collection bins and containers to place at vantage areas within the localities to make easy for the populace to dispose the waste appropriately. With the support the MMDAs should create collection depots, where the populace can bring and sell their collected plastic wastes for recycling.
- ❖ The Government should make the plastics manufacturing companies to pay levy on the amount plastic produce per year to support the plastic waste management in the country. The plastics companies should also be made to set up their plastic recycling plants either in groups or individual companies with support from the government, where import duties on mechanical recycling machinery could be free or 50% discount.

With the view of this thesis work, the author recommendation for further studies or research into best ways in solving or reducing the plastic wastes problems in Ghana.

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