



# PLASTIC WASTE MANAGEMENT IN ACCRA, GHANA.

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Roger Teye ( Author)  
Marriann Holmberg (supervisor)

Arcada University of Applied Sciences  
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Author:	Teye Roger Narh
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Supervisor (Arcada):	Mariann Holmberg
Commissioned by:	Karis Badal Durbo
<p><b>Abstract:</b></p> <p>Waste management is of importance not for developing countries but for the developed ones as well. A large amount of waste is generated daily in these countries and the question that is always posed is how these wastes could be best managed to help maintain a good environment and help humans to live in a healthy society. Many communities, towns and cities face this challenge and the Accra is no exception to this.</p> <p>Plastic waste appeared to pose a threat to the environment as it takes a longer period of time to decompose. Plastic waste also blocks drainages and choking soil and soil animals.</p> <p>Of the various ways of plastic waste management recycling seem to be the most efficient and economical way of handling plastic waste as it doesn't not demand so much expert skills and it's less expensive too. Recycling is also a way of reclaiming resources and creating employment as well. The mechanical way of recycling plastics was elaborated in the thesis.</p> <p>The literature survey was gotten from textbooks and other sources. Data was collected by the researcher during his survey of the Accra township. The compiled information and suggestions are expected to be helpful for managing plastic waste in Accra, Ghana.</p>	
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## **FOREWARD**

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## 1 INTRODUCTION

Waste management is of importance not for developing countries but for the developed ones as well. A large amount of waste is generated daily in these countries and the question that is always posed is how this waste could be best managed to help maintain a good environment and help humans to live in a healthy society. Many communities, towns and cities face this challenge and the Accra is no exception to this.

Waste generated in Accra is made up organic and inorganic wastes. The organic wastes is not much of a problem since it is biodegradable but it is the plastic waste which is much of a problem since it take a longer time to decompose. Plastic wastes are non-biodegradable they can stay in the environment for long period of time causing all sorts of problems to the environment and in turn to mankind and to the health of the society.

Combustion is one way by which plastic waste is managed in Accra but it is not environmentally friendly since it releases carbon dioxide to the atmosphere. Carbon dioxide is also known to be a major contributor to global warming. Plastic wastes are also used for landfilling and since plastics are non-biodegradable it is not the best way since it does not decompose and since of no economic value. The best way of managing plastic waste is by recycling. This is so because recycling is environmentally friendly and compared to other means of plastic waste disposal. Recycling of plastics creates employment and it is of economic importance to the nation and as well material and energy can be recovered instead of regarding it as trash.

The Accra Metropolitan Assembly (AMA) is responsible for the management of waste in the Accra municipality. According to the AMA about 9000 tons of wastes are generated in Accra daily, out of which 315 are plastic(AMA, 2010). In Accra and Ghana as a whole drinking water is packaged in sachets mostly and bottled water is not common. Residents of Accra has developed a strong like for sachet water since to them it is portable, affordable and they also consider it a clean than the bottled water. The public litter the city with the sachet after they have emptied the contents. These sachets constitute a large proportion to the waste generated in the city of Accra. Plastic has also replaced other material since it is considered cheap and efficient means of packaging. These plastic packages are easily and soon disposed after usage and these in turn litter the environment. These plastics block drainages, block the soil posing problems to small animals and damage the soil.

In recent times the city of Accra has faced floods due to blockages in the drainage system. There is also the problem of malaria since these blocked drainages serve as a breeding place for mosquitos. Cholera is also a health problem that has arisen as a result of poor waste management. Little has been done despite the problem that has arisen due to poor management of plastic waste. Hence the earlier something is done about the problem the better it would be for the environment and the livelihood of the residents in Accra.

## **1.1 Objectives**

The work aims at examining plastic waste in Accra, how they are managed and how they could be best managed. The objectives of this thesis work are in three (3) fold.

- Identify the different types of plastic wastes in Accra Ghana.
- Show how the different types of wastes could be managed
- Make recommendation for further research.

## **1.2 Literature sources**

Literature for this thesis was gathered from various sources. Most of the information was obtained from the internet, textbooks and previous works done on the topic. The researcher also visited a couple of plastic companies in Ghana and also waste management companies.

## **1.3 Limitation to the study**

One major limitation to this study was that the author was not able to gather accurate figures from the companies. This is so because most of the companies were hesitant to give out their data since they thought the author was working for one of their competitors. The researcher was also not able to visit the recycling plants since they were still under construction and visitors were not allowed to visit the sites.

## **1.4 Description of the Study Area**

Ghana is a nation with a population of about twenty two (22) million people. Accra is its administrative capital and serves as an economic and cultural center with a population of about two (2) million people. Accra covers about sixty five (65) square miles. It was founded by the Ga in the sixteenth (16<sup>th</sup>) century as a fishing village. The British chose Accra as an administrative capital of Ghana. Accra is made up of five (5) administrative districts namely, Accra Metropolitan Assembly, Ga, Tema, Dangme West and Dangme East. Recently, urbanization with the current growth in population has its implication on the environment.

The figure: 1 below shows the map of Ghana and the location of Accra (marked with red).





Figure 1: map of Ghana

Source: mapsofworld.com

## 2 LITERATURE SURVEY

### 2.1 What are plastics

Plastics are polymers. A polymer is an organic macromolecule (a large molecule based on carbon) comprised of several hundred or thousands repeating segments called mers linked together in a chain-like form. Each plastic is unique and there are thousands of them. [1]

Polymeric materials are large molecules made by joining together thousands of small molecules units known as monomers. The process of joining the molecules is called polymerization and the number of these units in the long molecules is known as degree of polymerization.

The term plastic refers to a family of materials which is made up of polymers and additives. Examples of plastics include nylon, polyethylene and PTFE just as zinc, aluminum and steel fall within the family of metals. [2]

Plastics can be gotten from petroleum, usually in the form of a light distillate or natural gas in the form of methane or from agricultural material in the form of wood/cotton, cellulosed/soya bean byproducts.

It is usual to think that plastics are a relatively recent development but in fact as part of the larger family called polymers they are a basic ingredient of animal and plant life.[2] Polymers are different from metals in the sense that their structure consist of a very long chain-like molecules . Natural material such as silk, shellac, bitumen, rubber and cellulose have this type of structure.

It was until the 19<sup>th</sup> century that attempts were made to develop a synthetic polymeric material and the first success was based on cellulose. This was a material called parkesine. Although, it wasn't a commercial success it was a start and led to the development of celluloid. This material was an important breakthrough because it became established as a good replacement for natural materials which were in short supply for example ivory for billiard balls.

In the 20<sup>th</sup> century, Bakelite was introduced in the 1909 just about the time when World War II materials such as nylon, polyethylene and acrylic appeared on the scene.

Unfortunately, many of the early application of plastics earned them a reputation as being cheap substitutes. It has taken them a long time to overcome this image but nowadays properties of plastics are being appreciated which is establishing them as important materials in their own right. The ever increasing use of plastics in all kinds of application means that it is essential for designer and engineers to become familiar with the range of plastics available and the types of performance characteristics to be expected so that these can be used to the best advantage.

The names of the many polymers consist of the name of the monomer with the suffix poly- . For example polypropylene and polystyrene are produced from propylene and styrene respectively.

An awareness of the structure of plastics can assist in understanding why they exhibit a time-dependent response to an applied force, why acrylic is transparent and stiff whereas polyethylene is opaque and flexible. It is not necessary for one to be an expert in polymer chemistry to be able to use plastics.

The words polymers and plastics are often taken as synonymous but in fact there is a distinction. The polymer is the pure material which results from the process of polymerization and is usually taken as the family name for the material which has long chain-like molecules (this includes rubber). Pure polymers are seldom used alone and it is when additives are present that the term plastics are applied. Polymers contain additives for a number of reasons. The following outline the purposes of the main additives used in plastics.

- ***Antistatic agent***

Most polymers because they are poor conductors of current build up a charge of static electricity. Antistatic agents attract moisture from the air to the plastic surface improving the surface conducting and reducing the likelihood of a spark or discharge.

- ***Coupling agent***

Coupling agent is added to improve the bonding of the plastic to inorganic filler material such as glass fiber. A variety of silanes and titanates are used for this purpose.

- ***Fillers***

Fillers such as short fibers flakes of inorganic materials improve the mechanical properties of plastics. Extenders improve a large volume of plastics to be produced with relatively little actual resin. Calcium carbonate, silica and clay are frequently used extenders.

- ***Flame retardants***

Most polymers because they are organic are flammable. Additives that contain chlorine, bromine and phosphorous / metallic salts reduce the likelihood for combustion.

- ***Lubricants***

Lubricants such as wax / calcium stearate reduce the viscosity of the molten plastic and improve forming characteristic.

- ***Pigments***

Pigments are used to produce colours.

- ***Plasticizers***

Plasticisers are low molecular weights which alter the properties and forming characteristics of the plastics. An important example is the production of flexible grades of polyvinyl or chloride by the use of plastics.

- ***Reinforcement***

The strength and the stiffness of polymers are supposed by adding fibres of glass carbon, etc.

- ***Stabilizers***

Stabilizers prevent deterioration of the polymer due to environmental factors. Antioxidants are added to ABS, polyethylene and polystyrene. Heat stabilizers are required in processing polyvinyl chloride. Stabilizers also prevent deterioration due to ultra-violet radiation.

## **2.2 Classes of Plastics**

### **2.2.1 -Thermoplastic materials**

Thermoplastic materials are plastics materials that soften upon heating and harden up upon cooling. This process is reversible just as ice hardens upon cooling but can be remoulded by heating. [1]

They have the very long chain-like molecules are held together by relatively weak Van der Waals forces. A useful image of the structure is a mass of randomly distributed long strands of sticky wool. When the material is heated the intermolecular forces are weakened so that it becomes soft and flexible and eventually at high temperature becomes viscous melt. When the material is allowed to cool it solidifies again. This cycle of softening by heat and solidifying on cooling can be repeated more or less indefinitely and it is a major advantage for this material. It also does have its drawbacks though. Examples are polyethylene, polyvinyl chloride, polystyrene, nylon, cellulose, polycarbonate and polypropylene.

Some plastics have the ability to achieve the level of crystalline but they are probably more accurately described as partially crystalline or semi crystalline. Other plastics such as acrylic and polystyrene are always amorphous (random).

Unlike thermoplastics, thermosets have chemical bonds between their long chain molecules. However, the way the thermoplastic molecules position themselves next to each other and the intermolecular forces that hold them together do affect their properties and classification. [1] Figure: 2 below depicts the structural difference between thermoset and thermoplastics.

### 2.2.2 -Thermosetting plastics

Are plastics compounded that “set” or cross-link upon heating. Thermosetting plastics usually are able to perform at higher temperature, which offers the plastic part designer a material with outstanding chemical and electrical resistance. Cross-linking process is irreversible, once set the thermosetting plastic cannot revert to its prior stage. An analogy is baking a cake [1]. Once the cake has been baked, the flour used for baking the cake cannot be gotten back with whatsoever means.

The chemical reaction into two stages, the first stage results in the formation of long chain-like molecules similar to these present in thermo plastics but still capable of further reaction.

The second stage of the reaction (cross-linking of chains) takes place during moulding, normally under the application of the heat and pressure. If excess heat is applied to these materials they will char and degrade. This type of behavior is analogous to boiling an egg. Once the egg has cooled and is hard it cannot be softened again by the application of heat.

Since the cross-linking of the molecules is by strong chemical bonds, thermosetting materials are characteristically quit rigid material and their mechanical properties are not heat sensitive.

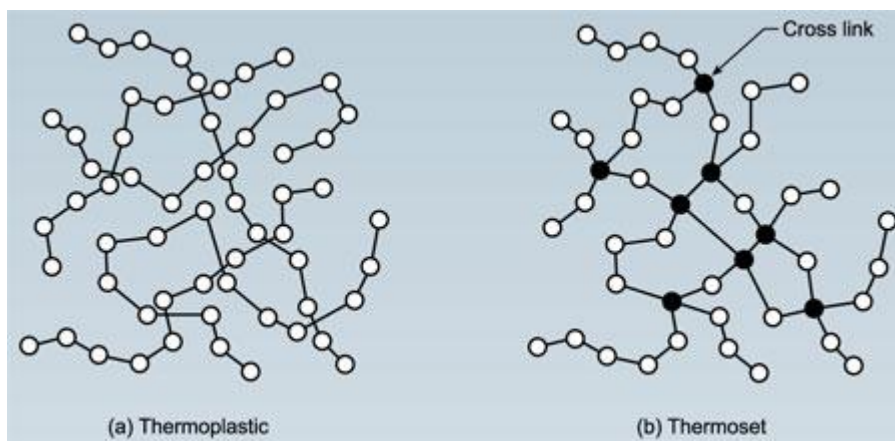


Figure 2: structure of: (a) thermoplastic and (b) thermoset

Source: nrc-cnrc.gc.ca

## 2.3 Forms of Plastics

Random entanglement of the thermoplastic molecules is called amorphous structures. They can be clear, have a uniform property in all directions and have a melting range versus a melting point e.g. PVC.

Thermoplastics in which the molecules have an order are called semi-crystalline. However, unlike the crystal structure in salt or metal, the molecules line up next to one another only occasionally. Semi-crystalline thermoplastics are characterized by opacity, no uniform properties and distinct / narrow melting range.

### Other forms of Plastics

- Elastomers are able to stretch two times its original length and fully recover.
- thermoplastics remain in their new shape if distorted
- rigid and maintain their shape
- flexible and easily folded or distorted
- ductile can be stretched or pressed without losing its integrity

### 3 PLASTIC PROCESSING

This is the process used to convert raw material into objects used by society. These raw materials may contain additives to produce the needed properties. These properties are usually physical and mechanic in nature. There are different ways and methods used to produce plastic product used in everyday life. The following are some of the process that was identified namely: Injection molding, Extrusion, Blow molding, Injection blow molding, Stretch blow molding, Extrusion blow mold

#### 3.1 Injection molding

Injection molding is a method of plastic manufacturing whereby the plastic materials are heated and homogenized in a barrel until there is enough pressure to forces the heated material into a mold cavity. The plastic material is then later cooled and when it is cooled, it takes the shape of the mold cavity. The mold cavity is usually made from steel or aluminum. The mold is made based on the size and design of the product to be manufactured. Figure 3 below shows an injection molding machine and its various parts.

This process is used for both thermoplastic and thermoset materials as well as some elastomers. Injection molding requires no post-molding operation and production speed is also rapid. These are some added advantages of using this process.

This process can also be used to manufacture tiny as well as large objects. This manufacturing method is used in Ghana to make bottle caps; packaging for foods and other products; storage container (usually for storing water); hair combs; chairs and tables which are made in one part.

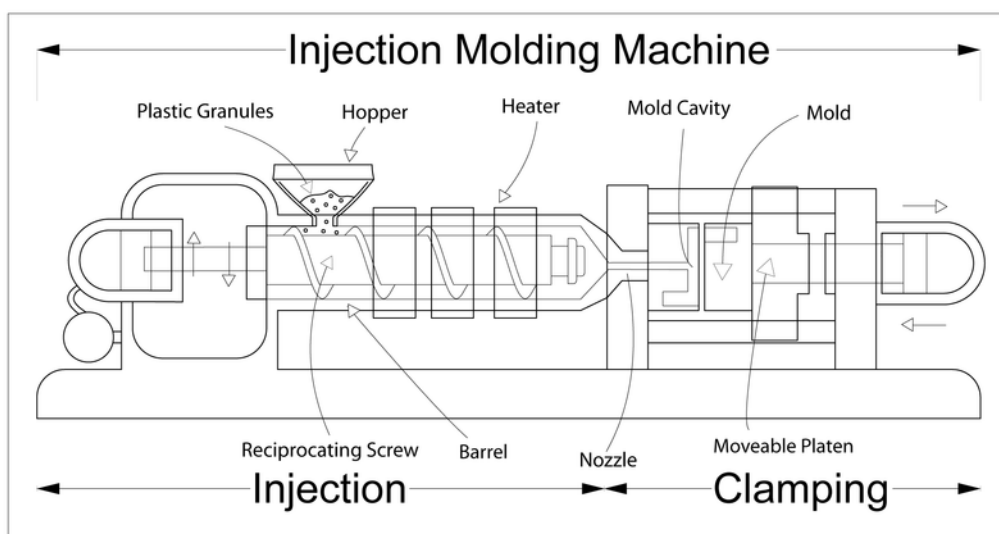


Figure 3: an injection moulding machine

Source: wikipedia.org

### 3.2 Extrusion

During extrusion the plastic material is drawn or pushed through a die to produce the required cross-section. Figure 4 below shows the plastic material being extruded through a die into a mold. Extrusion is a primary process used to produce objects after which other process such as blow molding is used to produce the desired shape. This process can be used to produce objects of very complex cross-sections and also work with material that are very brittle because compressive and shear stress are the stresses encountered during manufacturing [3]. The surfaces of the finished objects are also very excellent and long objects can be produced using this method.

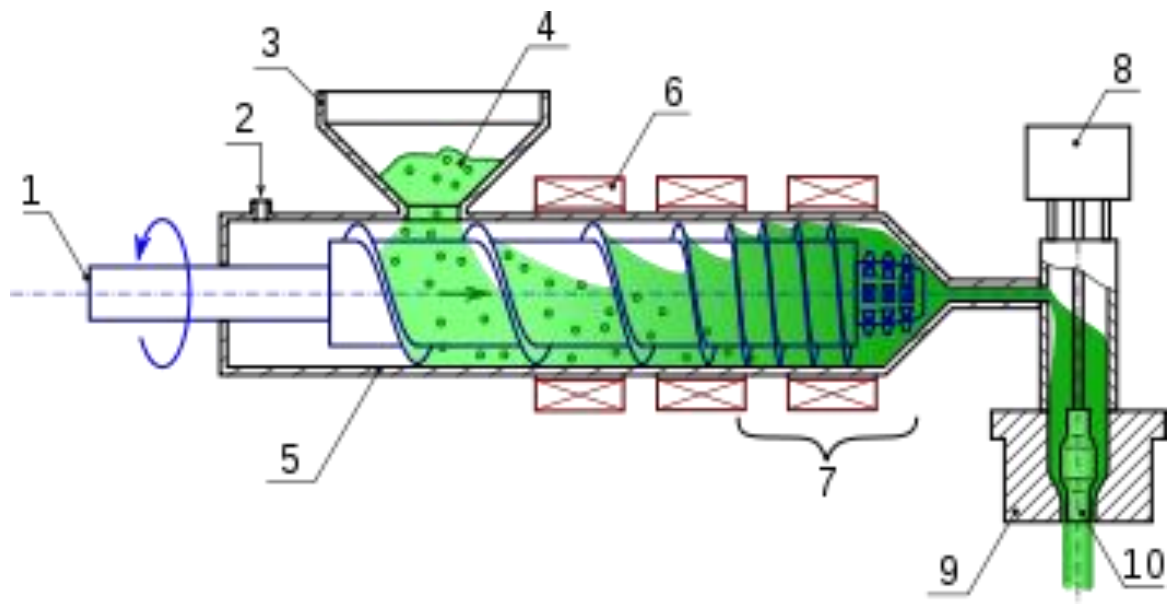


Figure 4: an extrusion machine

Source: wikipedia.org

### 3.3 Blow molding

Blow molding is a manufacturing process for producing hollow objects. This is a secondary process to extrusion. During blow molding, the material is heated up and melted into a forming tube (parison). The parison is made up of two parts; these parts are then clamped together after the melted material enters it. Air is then introduced into the parison through a hole at one end. The air is used to expand the material in the parison until it takes the shape of the mold. This mold has the required shape and size of the desired product. There are three types of blow molding, namely: injection blow molding, extrusion blow molding and stretch blow molding.



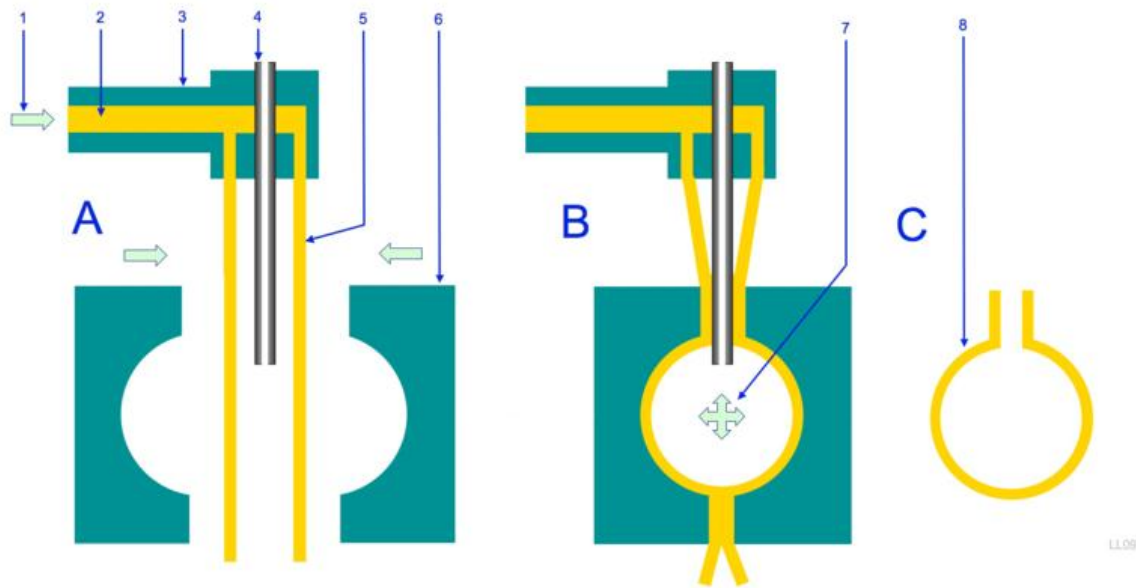


Figure 5: the mould part of a blow moulding machine

Source: Wikipedia.org

### 3.3.1 Injection blow molding

Injection blow molding starts with the process of injection. The pre-forms are produced by injection molding. Here the plastic material is introduced into a core pin which then rotates to a blow mold station. At the blow mold station the pre-form is then clamped by the mold and air is blown into the pre-form until it takes the shape of the mold. This is then cooled to produce the desired product. Afterwards, the blow mold opens and the plastic product is then ejected from the mold. The three stages of injection blow molding at the mold station are depicted in figure: 5 above.

Injection blow molding is usually used to make certain medical bottles and bottles that are used just once in everyday life. Injection blow molding is used to produce plastic products in large quantities.

### 3.3.2 Stretch blow molding

Stretch blow molding starts with the process of injection. Here the plastic products are first made into pre-forms using injection blow molding. After making the pre-forms the objects are later fed into a reheated stretch molding machine and the pre-forms are then heated up. High pressurized air is then blown into these pre-forms using metal blow molds. The various stages of stretch blow molding at the mold station is shown in figure 6 below.

Stretching of bottles made from PET may result in hardening of the resin used in making them. This process is used for making plastic bottle for carbonated beverages which is able to resist pressure formed by the carbonated beverages.

Advantages of this process are that it is cost effective, it can be used to make complex parts and it has a high production rate.

The disadvantage of this process is that it is limited to hollow parts or product.

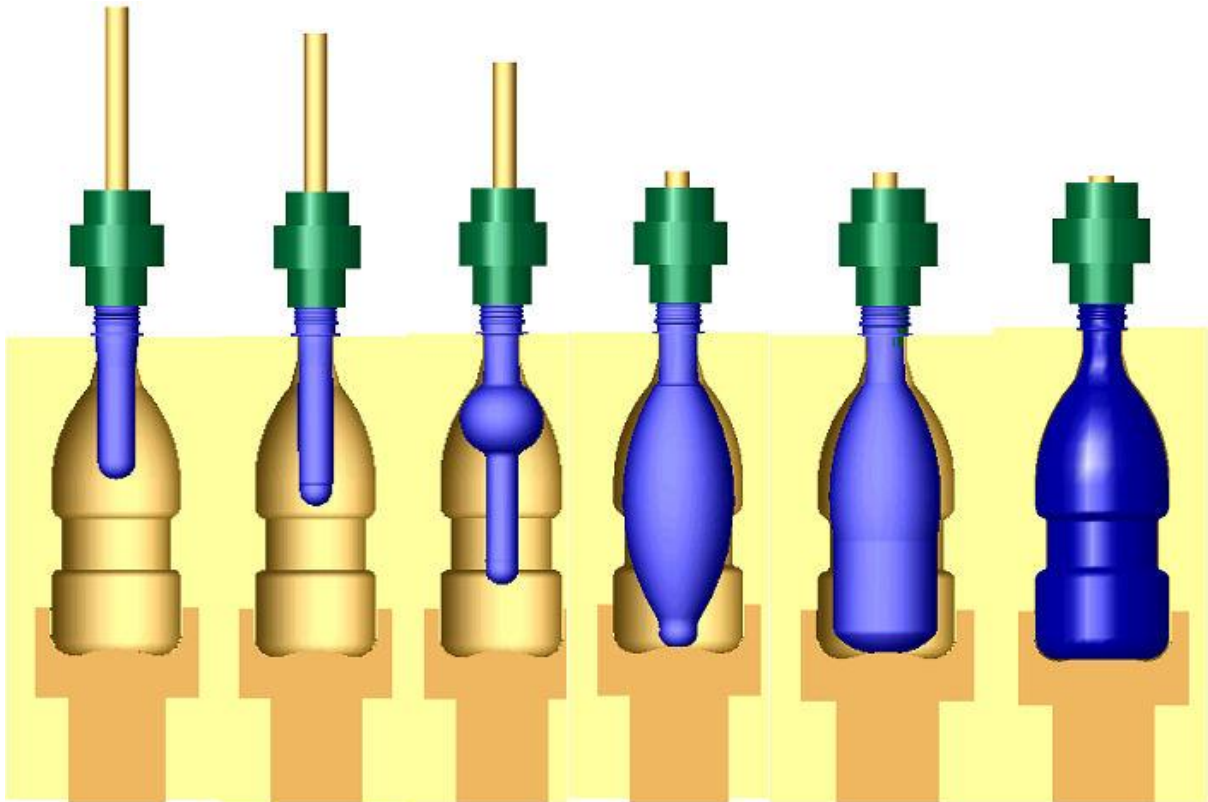


Figure 6: the mould part depicting stretch blow moulding

Source: Wikipedia.org

### 3.3.3 Extrusion blow mold

The plastic raw material is melted into a parison. It is then introduced in a cooled mold and air is then blown into the parison, inflating it into the required shape and size. After cooling the mold is opened and the product is ejected from the mold. Extrusion may either be continuous or intermittent.

## **4 THE SITUATION IN GHANA.**

### **4.1 Introduction**

The republic of Ghana has a population of about 22million residents with Accra being its capital town. Accra acts both as the economic and administrative capital of the country. It has a natural port and it covers about 65 square miles. Accra has about 4million inhabitants and more than half of the residents live on less than a dollar a day.

There are about 140 plastic companies in Ghana. Most of them are located in the southern part of the country, predominantly in the Greater Accra region. Out of these 140 companies only 20 of them collect the byproducts and re-use it later, the rest of the companies dispose the plastic waste since they think it is tedious and expensive to re-use the plastic. Most of these companies operate on a small scale and they have a limited range of items that they produce (Zoomlion Accra, 2010).

On the whole these companies import about 230,000 tons of raw materials per annum. About 210,000 tons of raw materials are used per annum to make plastic products. Out of these 210,000 tons of plastics used to make plastic products, about 40,000 are used and re-used; the rest of the 170,000 tons goes to waste. About 2,000 tons out of the 170,000 tons are recycled. There is only 1 company which takes care of this recycling. This recycling is done on a small scale.

### **4.2 Different fields where plastic are used**

There are several plastic products made in Ghana. There are ranges of plastic product used in homes, schools, factories and also in construction. Most of the plastic products are consumed by domestic households and they usually have a difficulty in disposing off the products properly after use.

#### **4.2.1 Packaging materials**

Plastics are primarily used in the packaging industry. Plastics are used in the food industry for packaging certain foods. Containers used in packaging food are produced from polypropylene and polyethylene (PE) by the process of injection molding. These containers are used to store frozen, fresh, cold or hot foods. They are also used in packaging cereals, fruits, oily foods as well as some acidic ones too. These ready packaged foods are usually found in the supermarkets and malls otherwise food is usually packaged immediately when the consumer buys them. Figure 7 below shows some foods packaged in containers made from polyethylene.



Figure 7: PE for food packaging

Source: [packaging-gateway.com](http://packaging-gateway.com)



Figure 8: PET and PE for food packaging

Source: [packagingeurope.com](http://packagingeurope.com)

Polyethylene terephthalate (PET) are also used to make peanut and other food jars and also for making containers for packaging microwavable foods. High density Polyethylene (HDPE) is also used for making detergent bottles and milk jars. Polyvinylidene chloride (PVDC) is also used for food packaging. Figures 8, 9 & 10 shows different types of plastics and how they are used in packaging some products.



Figure 9: HDPE for food packaging

Source: dustbowl.wordpress.com



Figure 10: PETE for food packaging

Source: dustbowl.wordpress.com

Foods are usually brought to the warehouse of shops in large quantities and these companies hire people to re-package them in smaller quantities for purchase by the consumers. Re-packaging food items by shops are usually done using plastics.

When plastics are used to store foods, the containers are usually locked tight and leak proof so as to ensure a safe transportation.

Certain non-alcoholic beverages and fizzy drinks are also stored in plastic bottles. It is very common for one to find fruit drinks and other beverages packaged in Polyethylene terephthalate (PET) bottles.

Certain alcoholic and non-alcoholic drinks usually water and fruit drinks are also packaged in sachets. Other items such as detergents, screws, bolts and nuts, watches, disposable cutlery, buttons, etc. are packaged in sachets.

Water is also stored and served in plastic containers. Purified water is commonly packaged in sachets while spring water is packaged in PET bottles.

It is very common to see food vendors at the roadside or market squares serving foods in plastic containers. These plastic containers are mostly made from Polystyrene (PS). Even after serving these foods in these plastic containers the foods are then packaged in plastic bags usually made from polyethylene.

#### **4.2.2 Electrical equipment:**

Plastics are used to make certain electrical equipment. Plastics are used to manufacture light switches, plugs, phone housing and casing, traffic lights, parts of computers, parts of heaters and refrigerators. Plastics are used as insulators in the manufacture of wires and other electrical gadgets. Wires of most gadgets are enclosed in some type of plastic. Figure 11 below shows a wire enclosed in a plastic for a certain electrical gadget.



**Figure 11: Plastic used in the manufacture of wires**

Source: [dustbowl.wordpress.com](http://dustbowl.wordpress.com)

High impact polystyrene (HIPS) is used for making refrigerator liners. It is very common to see people take the old refrigerators to the repair shop to have their lining fixed.

Acrylonitrile butadiene styrene (ABS) is mostly used to manufacture electronic equipment cases and mobile phone housing as shown in figures 12 &13. Polycarbonate (PC) is used to manufacture traffic lights.



Figure 12: ABS in making mobile phone cases

Source: author



Figure 13: ABS in making laptop cases

Source: author

### 4.2.3 Health care:

In the healthcare sector plastics are also used in manufacturing certain devices and equipment. Plastics are used here to produce bottles for storing medicines. They are also used to make disposable gloves, plates, bowl, cups and spoons used by the health sector on daily basis. Plastics can also be found as parts of equipment used by doctors e.g. syringes, sphygmomanometer, thermometers, pulse oximeter and stethoscope. Figures 14 & 15 show some equipment used in the health sector made from plastics.



Figure 14: pulse oximeter

Source: tootoo.com



Figure 15: depicts a sphygmomanometer

Source: traddevv.com



#### 4.2.4 Building:

Plastics are used in buildings and in other construction works. In building houses, they are used mainly for roofing, ceiling and as lining in the main foundation which serves as a waterproof.

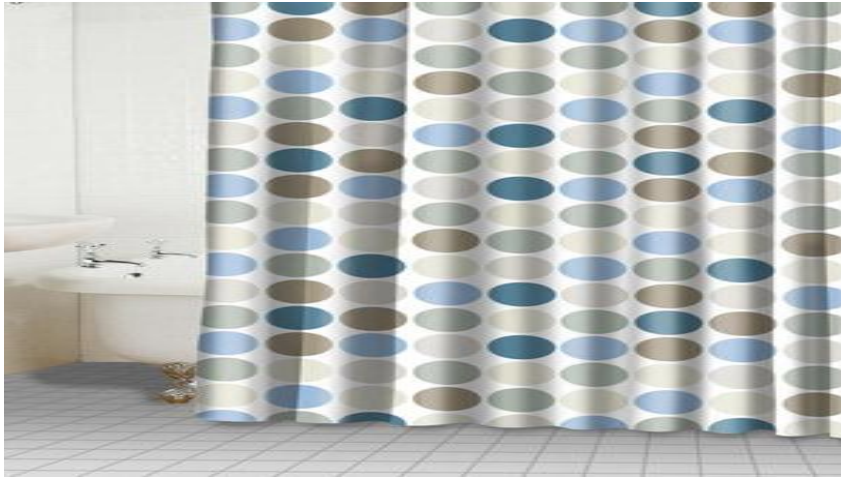
Polyvinyl chloride (PVC) is used mainly in the plumbing works in the house. Plastics are also used as roofing and also used for making drainage gutters in roofing as shown in figure 16 below.



Figure 16: depicts a plastic roof and its drainage gutters

Source: [archiexpo.com](http://archiexpo.com)

High density polyethylene are used for manufacturing outdoor furniture (garden chairs) and also for making shower curtains. This is shown in figures 17 & 18 below. Polypropylene (PP) is used to make plastic pressure pipe systems during construction.



**Figure 17: Polyethylene in the manufacture of shower curtains**

Source: [cheapestshowercurtains.com](http://cheapestshowercurtains.com)



**Figure 18: High density polyethylene in the manufacture of garden chairs and tables**

Source: author

Polycarbonate (PC) is used to manufacture security windows and roofs which allow sunlight to penetrate through as shown in figure 19 below. Most of these roofs are used in greenhouses.



Figure 19: Polycarbonate (PC) is used here to make a roof for a house

Source: [dustbowl.wordpress.com](http://dustbowl.wordpress.com)

Polyurethanes (PU) are cushioning foams and insulation foams. These are used in construction sites where the floor is cold.

#### 4.2.5 Others Uses:

Plastics are also used to manufacture kids toys, small clothing, buckets, pet containers, chairs, car tires, car parts, mattresses, floor waxes, sponges, synthetic leather, trash can liners, ash trays, beverage cases, egg cartons, floor carpet, piano keys, pen and pencil barrels, water hose nozzles, football helmets, cycling helmets, toothbrush bristles and handles, shoe heels, buttons, doorknobs and brush bristles.

Polypropylene (PP) is used for manufacturing bottle caps, drinking straws, plastic pressure pipe systems, car fenders and bumpers. These bottle caps and drinking straws come in different shapes and sizes. Their colors also vary based on what purpose it used for. Nevertheless, bottle caps and drinking straws come in different range of colors. Some even do come in more than five (5) different colors.

Polyester (PES) is used for making fiber and textiles. There are about three (3) main companies that produce textile in Ghana. They use polyester to manufacture mostly of their cloths adulterating it with cotton. It is very rare to see that polyester is used solely. Most of the cloths that are made from polyester only are imported from Nigeria and China. Figure 20 below show textiles made from polyester.



Figure 20: depicts textiles made from Polyester (PES)

Source: made-in-china.com

Polystyrene (PS) is used for Compact Disk (CD) and cassette cases, plastic table wares, disposable cups, plates and cutlery. In most parts of the world the use of compact disks has almost completely replaced cassettes but this is not the situation in Ghana. Most people still do have their cassette players in use. Moreover cassettes are less expensive compared to compact disks and they are easy to handle as well.

Plastic table wares have been in use since plastic products were introduced to Ghana but disposable cups, plates and cutlery is a recent phenomenon. The widespread use of disposable cups, plates and cutlery arose with the increase size of people appearing in public and private functions e.g. wedding ceremonies, funerals, parties, naming ceremonies, baptism, confirmation ceremonies and other local festivals. These cups, plates and cutlery are less expensive and do not require cleaning after its use hence, the widespread usage. Figure 21 below shows some colorful plastic wares used in most households in Ghana.



Figure 21: depicts plastic cutlery made from Polystyrene (PS)

Source: manolohome.com

Polyamides (PA) are used for making toothbrush and other brush bristles and also fishing lines. Brush bristles come in different shapes and texture, ranging from hard to soft. Lines for fishing ought to be strong enough otherwise it will tear every now and then that's why most are made from polyamides.

Polycarbonate (PC) is used to manufacture riot shields due to its physical properties. The local mechanics also use polycarbonate to make parts of cars and fishing vessels.

Acrylonitrile butadiene styrene (ABS) + Polycarbonate (PC) are used to make and decorate the interior of cars. Most cars in Ghana already have the manufacturer design and make of every car's interior but the interior very old cars and accident cars are renovated using these

materials. Some people by their own wish some make the interior of their cars to suit their taste.

Polyurethanes (PU) are used in making cushioning foams and insulation foams. Cushions are used for making the interior of cars, making sofa beds, beds, sofa chairs, parts of shoes etc.

Lastly, plastics are used in the manufacture of ice chest food flask which is used for storing cold or hot foods. These ice chest and food flasks are air tight and this doesn't allow air in and out of the containers. The aim is to keep the food at its temperature a long as possible.

## 5 OVERVIEW OF WASTE MANAGEMENT IN GHANA

There is a waste management in Ghana on both the national and local level. Waste is not properly managed in the urban areas as well as the rural areas.

In Accra about 65% of the waste that comes from people's homes can be categorized as organic waste. The organic wastes that come from people's homes are usually made up of kitchen waste (food residues, vegetables, fruits and leaves) and animal excreta. In Accra, most people keep animals at home as pets and also for domestic consumption. The organic wastes from households are not toxic to the environment. The rest of the 35% of the wastes are made up metals, glass, paper, plastic and textiles.



Figure 22: depicts a drainage blocked with waste mostly plastics

Source: author

Many households in Accra store their wastes in plastic bags and basket containers. These organic wastes decompose due to the hot and humid weather. Organic wastes are usually disposed other the decomposing wastes attract flies usually houseflies. These flies contaminate household foods and cooking utensils. The contamination produced by houseflies' results in the widespread of diarrhea. About 20,000 people die every year in Ghana as a result of diarrhea related cases and it's a common for people to report to the outpatient department in hospital complaining diarrhea.

Outside the homes residents dispose wastes on open surfaces and drains. When the drainages are blocked by these wastes they serve as a source for breeding mosquitos, frogs and other flies. These mosquitos spread malaria and malaria accounts for about over 50% of the

diseases reported at the outpatient department in hospitals in Ghana. Figure 22 above shows drainage blocked with wastes mostly plastic.

Due to lack and inadequate facilities and infrastructure in Accra some residents end up defecating outside in nearby bushes and sometimes in some water bodies. Due to this practice there is widespread of cholera and diarrhea. This occur mostly during the raining season as the run offs carry these human excreta with it and in turn contaminates households.

Composting is the process by which organic wastes are turned into fertilizers. Residents usually use these fertilizers in their backyard gardens and on their lawns. Out of the 1250 tons of garbage collected in a day only about 10- 15% of the waste is composted. Theoretically, composting reduces environmental pollution and may provide some job opportunities if all the wastes are composted.

Solid wastes are also used to fill lands. The Accra metropolitan assembly has appointed designated sites as places for landfills. These sites are usually open for residents to dump their solid wastes there with a token fee or no charge at all. In Accra there are no engineer landfills. Due to this certain chemical and other toxic substances can leak to the environment and affect the residents nearby.

Currently, waste management is still not yet developed so most of the landfill sites are out of capacity. The wastes are not compacted and the waste keeps expanding. This attracts rodents, flies and roaches.

Incineration is the process by which combustible waste are burn in ashes to reduce the waste products in the environment. This is mainly used to mostly to dispose biological waste in the medical sector. After incineration the wastes are used as landfills.

Recycling is done on a very small scale in Ghana. Households in Accra do not dispose paper, plastics, bottles and cans readily. Materials that are recyclable are mostly used and re-used and when they are no longer in use, they are disposed. In Accra there are two main recycling plants.

## **5.1 Plastic waste**

Accra has a current population growth of about 3.5% per annum and waste is averagely generated at a rate of 0.8kg/cap/day. In the year 2000, Accra had a population of about 1.7million people and 1,162 tons of waste was generated in a day. With a population of about 2.0million people in 2005, 1,375 tons of waste was generated in a day. Lastly, in 2010 with a population of about 2.4million people, about 1,622tons of waste was generated in a day. Currently, it is estimated that about 1,800 tons of waste is collected in the year 2011.



**Table 1 : shows waste produced in Accra**

<b>Waste type</b>	Organic i.e. Food and plant	Paper	Textile	Plastic	Glass	Metal	Inert	Others
<b>Proportion</b>	65%	6%	1.7%	3.5	3%	2.5%	17.1%	1.2%

Source: waste management department AMA

## **5.2 Sources of plastic waste in Ghana**

Plastics constitute to about 3.5% of the total waste collect in Accra. Plastic waste may be categorized into two (2): primary and secondary waste. The primary wastes are those that the manufacturing industries generate themselves while the secondary wastes are those that are generated from other sources other than the industry. The sources of plastic waste can be narrowed to three main sources in Accra. These are domestic, commercial and industrial sources.

### **5.2.1 Domestic waste**

Here wastes come from households, streets, parks, collection depots and waste dumps. In Accra substantial amount of plastic waste come from this category due to the littering habits of the populace. It is very common to see in the streets sachets, plastic carrier bag, food wrapping and other forms of packaging as these items are immediately disposed after use.

### **5.2.2 Commercial waste**

A huge amount of plastic waste comes from this category. Here plastics are used as packaging material. The most common type of plastic used here is PE, polyethylene. Supermarket, hotels, restaurants, craftsmen, retailers, wholesaler, etc. use polyethylene, PE.

### **5.2.3 Industrial waste**

Here the wastes come from big plastic production, manufacturing and packaging industries. These are usually industrial waste and materials that have been rejected by the consumers. These materials are usually in good shape and are not very dirty compared to the secondary wastes.

## **6 PLASTIC RECYCLING**

### **6.1 Collection**

Plastic wastes from the municipal are collected and sorted out by the locals and sold to traders. This is very labor intensive but large amount of money is not required for the collection. There are several places where plastic wastes could be collected: homes, garbage dumps, garbage container and garbage trucks. If the plastic wastes are close to the factory they are less likely to be dirty and mixed up.

### **6.2 Cleaning**

After the collection of the plastic wastes they are then washed and dried. Washing and drying is the main activity at the cleaning stage. Different people have different ways of cleaning (washing and drying) plastic wastes.

#### **6.2.1 Washing**

Washing of plastic wastes is very important since it makes the items look nice and this attracts a good price and they also give the end product a good quality. If the plastic wastes are not properly washed it may have foreign material attached to it thereby tempering with the properties of the product. These foreign materials may include: stickers, glue and labels.

Washing of plastic wastes can be done manually or mechanically. Manual washing involves the plastic waste being washed in basins, bath tubs and half cut barrels or gallons. The waste is usually stirred with a paddle in these basins. When the plastic wastes are a bit greasy hot water together with a grease removing detergent is used here. The stickers and other foreign materials are usually removed prior to the washing.

Mechanically, the plastic wastes are soaked with water in a basin for several hours. These basins have a paddle in them and after soaking it the paddle with is connected to a motor is turned on and it stirs up the water for some time and the water is poured out of the basin.

Most of the plastic wastes are very dirty except for the ones that come from the industries.

#### **6.2.2 Drying**

After washing the plastic wastes come drying. Washing and drying of the waste most of the time takes place at the same place. The plastic wastes can be dried manually or mechanically.

Manually, this is done by spreading out the plastic on a table or on the floor outside to allow the sun to dry it. Large sheets of plastics can also be hanged on drying lines and held with pegs.

Mechanically, it can be done using a heat of about seventy (70) degrees Celsius. This is done with a thermal drying machine.

### **6.3 Sorting**

Plastic wastes need to be sorted out before they can be recycled. This is so because plastics can be grouped into different categories and used for different purposes. The following are some ways by which plastics can be sorted

#### **6.3.1 Manual**

Manual sorting of plastics is done by human being and they sort the plastics based on their expertise. Plastics are sorted using the human eyes and foreign materials are also taken out from the plastics.

#### **6.3.2 Sorting based on density**

Sorting based on the density of the plastics is done in a floating sink and sometimes certain types of plastics are difficult to separate since they have the same densities. The specific gravity of PET and PVC are almost the same and make it difficult to separate them.

In the float sink different fluids are used so that plastics of less density floats and that of higher density sink. One disadvantage of this process is that it is very slow and it takes a longer time to carry out.

### **6.4 Size reduction**

Before the plastic wastes are recycled, their sizes are reduced in order to make way for easy transport and handling of the material. Size reduction can be done using the following techniques:

#### **6.4.1 Cutting**

This is the first step in reducing the size of the plastic waste is cutting them into smaller pieces. Plastic wastes such as big bowls, buckets, gallons and basins which cannot fit into the shredder are cut into smaller pieces before they are fed into the shredder. The cutting is usually done using a saw and the piece fall into a basin or on the floor and later collected and fed into the shredder.

#### **6.4.2 Shredding**

During shredding the plastic waste is fed into a shredder. This is a secondary activity to cutting, thus prior to shredding come cutting. Plastic pieces are fed into the shredder based on their type, color or the product to be made. Figure 23 shows a man feeding a shredder with plastics.

Usually before shredding the plastic wastes are cleaned but they are not cleaned before the shredding, then the cleaning is done after the shredding. Figure 24 below show how shredded plastics looks.

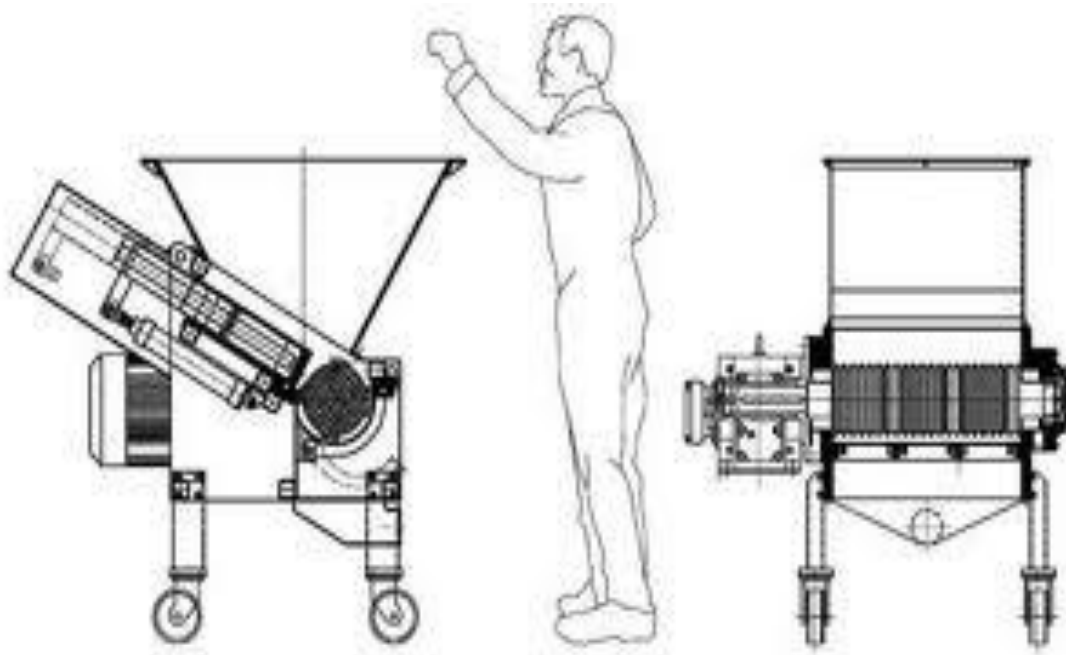


Figure 23: depicts a man feeding a shredder with plastics

Source: hardenmachinery.com



Figure 24: shows shredded plastics

Source: recyclingportal.eu

### 6.4.3 Agglomeration

An agglomerator is used to cut, pre-heat and dry soft wastes since it is not best to feed them into the extruder in that state. Agglomeration increases the efficiency of the material and gives the product a good finish. Agglomeration involves the coalescing of small pieces of plastics into a clump. Figure 25 below show an agglomeration machine while figure 26 shows agglomerated plastics.

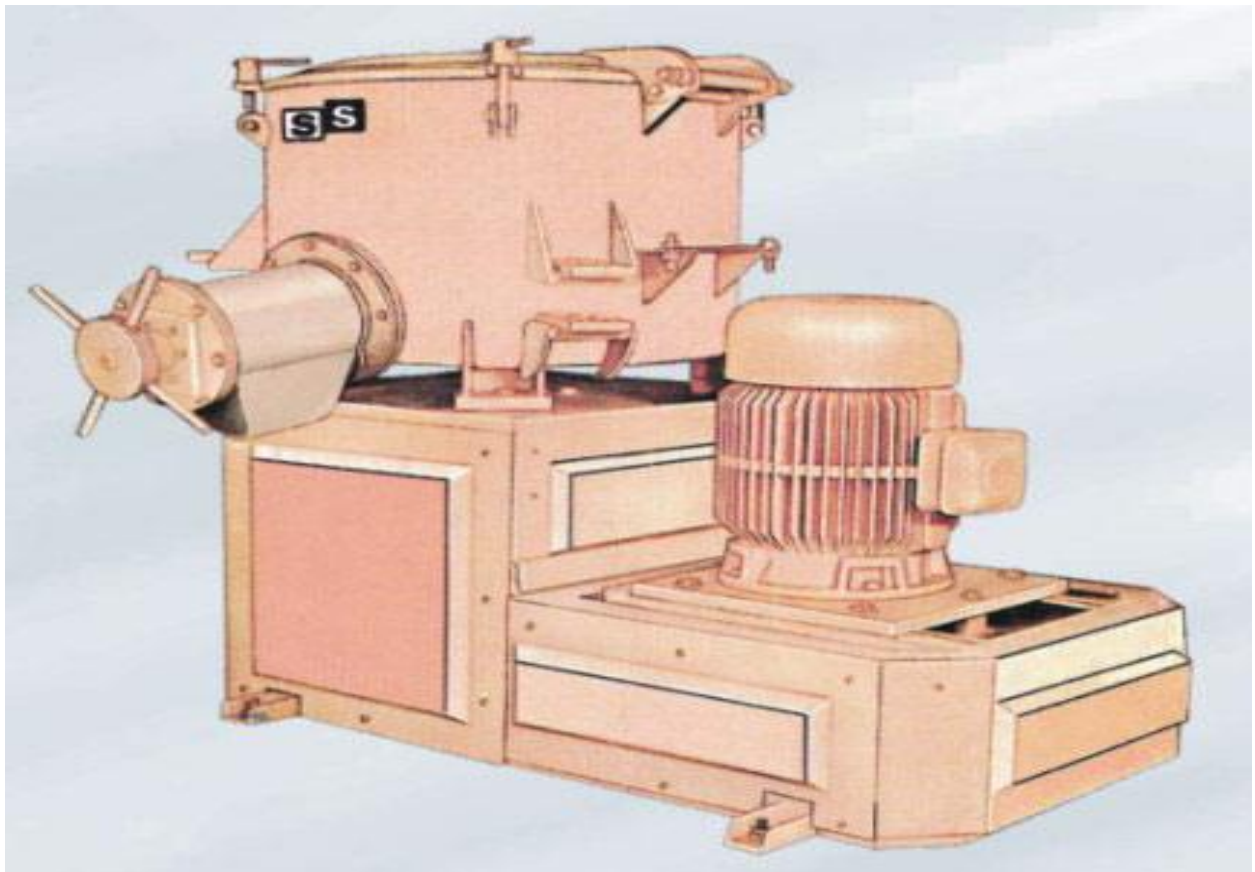


Figure 25: shows an agglomerator

Source: [plastic-extrusion-machinery.info](http://plastic-extrusion-machinery.info)



Figure 26: shows an agglomerated plastic

Source: sicontechnology.com

#### 6.4.4 Pelletizing

Pelletizing is the process of molding or compressing pieces of plastics into pellets. Usually agglomerated or shredded plastics are turned into pellets by pelletizing via extrusion as shown in figure 27 below.

During extrusion the additives are added to the materials and fed into the hopper in the extruder. The materials are then picked by the rotating screw in the extruder and forced through a barrel into the die. The heat generated by the rotating screw melts the materials. A spaghetti-like material is produced after the material is passed through the die. This spaghetti-like material is then cooled by the outside air or by passing it through water as shown in figure 28 below.

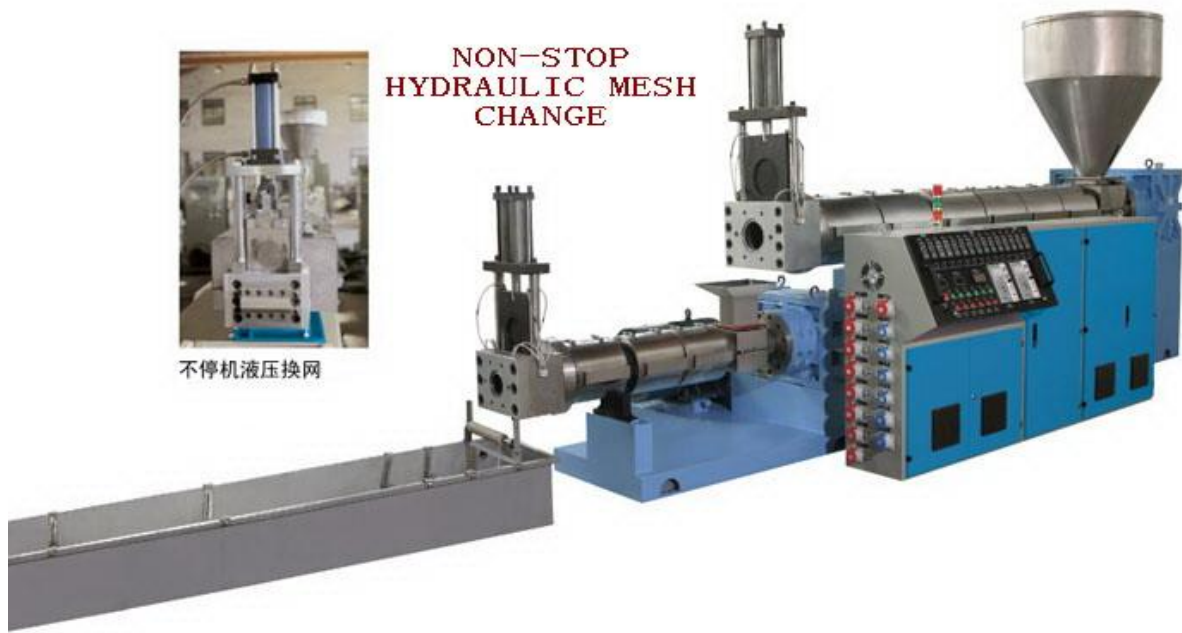


Figure 27: shows a pelletizing machine

Source: [zhongsumachine.en.made-in-china.com](http://zhongsumachine.en.made-in-china.com)



Figure 28: shows a local operating a pelletizing machine

Source: valenzuela.olx.com

## 6.5 Products produced by recycling

There are several products that are produced by the process of recycling. Since the raw materials gotten from already used products is not strong enough, virgin raw materials and additives are added to it before the recycling process takes place. This is done to ensure that the finished product possess the required physical and mechanical properties. The following are products produced from recycling:

- Garden chair (as shown in figure 18)
- Children's toys
- Plastic plates, cups, cutlery and table wares
- Parts of cars. For example bumper and lights
- Watch straps and clocks
- Mobile phone casing.
- Bathroom slipper and rubber boots.
- Carrier bags
- Identity card
- Beverage bottle and food containers



## **7 CONCLUSION AND RECOMMENDATIONS**

### **7.1 Conclusion**

In Accra and Ghana as a whole collection and disposal of waste is considered the responsibility of the government. However, the governments in less developed countries do not have adequate funds, means and measures to manage these wastes. This is so because the production of waste is higher than the institutions the government has created because of the increased rate of the population growth.

As a result of the problem stated above there is the need for the government to support recycling of plastic as plastics take longer time to decompose. Supporting recycling will complement the existing structure and means of waste management in Accra.

Recycling will create employment for some section of the population and help maintain the environment from pollutants. This turn will improve the health of the people. Recycling is not so profitable since the factories consume so much electricity and the government could help recycling companies by cutting down their electricity bills.

The municipal assembly needs to provide waste containers also at vantage points so these containers need to be emptied on regular basis. These containers need to be provided for different types of wastes so that sorting out plastic wastes would be less tedious. For a very good and efficient waste management in Accra, plastic recycling should be encouraged and supported by the government and everybody.

### **7.2 Recommendations**

For recycling of plastic wastes in Accra to achieve its purpose of not polluting the environment and its consequences the following recommendations could be useful.

The general public should be educated on the use of plastics and its effects on the environment. This could start at the grass root level by educating young pupils in schools then to the community by organizing seminars for them. The public needs to also be educated to be patriotic and be each other's keep. By this when one forgets and starts littering the environment the other can help them to do the right thing.

Secondly, the municipal assembly must make the companies producing these plastic products to in a way contribute to the recycling of plastic wastes. Import tariffs could also be put on imported plastic products so as to help contribute to the recycling of plastic wastes.

Thirdly, the municipal assembly should also provide depots for collection of plastic wastes. This will help the domestic household to properly dispose their plastic wastes. The municipal

assembly can encouraged this practice by providing people who use this depot by giving them souvenirs or a token money.

Lastly, recycling companies should also get some funds for operation so that they can operate on a large scale.

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