PRODUCTION OF CANDLE WAX FROM POLYETHYLENE (PURE WATER SACHET)

BY

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REG. NO; 2001/11616EH

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE BACHELOR OF ENGINEERING (B. ENG.) DEGREE IN CHEMICAL ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY MINNA

NOVEMBER, 2007

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NOVEMBER, 2007.

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CERTIFICATION

This project titled "PRODUCTION OF CANDLE WAX FROM POLYETHYLENE (PURE WATER SACHETS)" meets the regulation governing the award of the degree of bachelor of engineering of the federal university of technology, Minna and is approved for its contributions to scientific knowledge and literary presentation.

Engr.(Mrs.) Eterigho E.J

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(Head of department)

Date:--------------------------

External examiner

Date:----------------

DEDICATION

To GOD almighty, that has being my strength and stronghold and to my parents for everything that I received.

ACKNOWLEDGEMENT

My heartfelt appreciation and gratitude goes to the Almighty, the compassionate for his guidance and protection throughout my academic journey. I appreciate the contribution of my supervisor Engr. (Mrs.) Eterigho E.J who despite her tight schedule took time to go through the work.

My profound gratitude goes to the entire staff s of chemical engineering for their effort towards making me who iam, Iam sincerely grateful to you all.

My thanks and appreciation goes to my Dad Mr.B.A.Olayi for his relentless effort in making sure that my basic needs are met.

To my brother and sisters and the entire family for their love and care

To all my classmate and friends (Ikos, Ben, Moses, Abdul, Raymond and George) I thank you guys with all my heart and I wish you all the best things in life.

Abstract

Candle wax was produced from pure sachet (polyethylene) through the process of recycling. The pure water sachet (polyethylene) which was collected from the environment went through pre-treatment processes such as washing, drying and shredding/cutting into pieces, it was then put into a pot and subjected to heat for about one hour five minutes (1hr 5mins) until it began to melt at a temperature of 350^{0}C (M.pt). Paraffin oil and stearic acid were added to the molten wax and then and poured into a mould and allowed to cool in order to solidify. The result obtained was a dark green candle and when compared with standard it burnt slower than the normal paraffin wax base candle which is due to the ratio of paraffin oil to polythelene (pure water sachets).

CHAPTER ONE

1.0 Introduction

The need for diversified economy and the need to diverse attention from crude oil based economy have brought about increased industrial and agricultural activities. Thus, the menace of improper management of waste from these industries and indiscriminate dumping of this associated waste product.

This project is basically a waste management measure aimed at proper waste management and wealth creation by way of recycling, using polyethene waste as a feed stock. The choice of polyethene is practically because of its non-biodegradable nature and the menace of its continuous accumulation in the environment.

The bulk of these waste which is composed of mainly polyethylene (polyethene) and plastic of all types are produced in greater volume than any other solid waste, this can be attributed to the fact that disposable polyethene bags are used in the package of drinking water and other gift items.

Due to the increasing menace posed by indiscriminate and improper disposal of these packaged water sachet into the environment, this project seeks to find a way of putting to use these solid waste by way of converting it to useful product (Candle).

This research is geared towards producing candle wax blend of mainly polyethene which when produced in commercial quantity can meet the required standard obtained from the usual paraffin based wax blend.

1.1 Aims and objectives

The main aim of this project is:

To produce candle from candle wax based mainly on polyethene

The objectives of this project are:

- To manage the waste in the environment constituted by packaged water sachets by way of recycling
- To keep up with sanitary standards, by maintaining a clean and healthy environment.
- To find out suitable additives in the production of polyethene based candle wax blend
- To create wealth from waste

1.2 Approach/ Methodology

The above aims and objectives will be realized through the following approach.

-Collection of waste (packaged water sachets)

-Washing and drying to remove dirt

-Removal of sachet prints

-Mould preparation

-Addition of additive(s)

-Preparation of polyethene based wax blend

-Molding and candle finishing

CHAPTER TWO

Literature Review

2.1 Polymer

Polymer is a long chain molecule that is composed of a large number of repeating unit of identical structure.

Certain polymer, such as proteins, cellulose and silk are found in nature, while many others including polystyrene, polyethylene and nylon are produced only by synthetic routes.

The birth of polymer science may be traced back to the mid nineteenth century in the 1830s.charles good year developed the vulcanization process that transformed the sticky latex of natural rubber to a useful elastomer for tire use .In 1847,Christian F.Schonbein reacted cellulose with nitric acid to produce celluloid. In 1907,Leo Backland produced Bakelite (phenol-formal dehyde resin),and glyptal (unsaturated –polyester resin)was developed as a protective coating resin by general electric in 1912.Bythe 1930s,researchers at Du Pont in the united states had produced a variety of new polymers including synthetic rubber and more exotic materials ,such as nylon and Teflon. In 1938 Dow has produced several tons of polystyrene and in 1939 polyethylene (low- density) was made for the first time (Joel Fried,1979) .Today, polymeric materials are used in nearly all areas of our daily life and their production and fabrication are major worldwide industries.

2.1.1 Rheology

This is a phenomenon of polymer melt. It is he study of the deformation and flow of matter under the influence of an applied stress. In practice rheology is principally concerned with extending the classical disciplines of elasticity and Newtonian fluid mechanics to materials whose mechanical behavior cannot be described with the classical theories. I is also concerned with establishing prediction for mechanical behavior (on the continuum mechanical skill) based on the micro or structure of the material, e.g the molecular size distribution in a solid suspension.(http://wikipedia.org/wiki/rheology).

Rheology writes the seemingly unrelated fields of plasticity and non Newtonian fluids by recognizing that both of these types of materials are unable to support a shear stress in a static equilibrium. In this sense, a plastic solid is a fluid. Granular rheology refers to the continuum mechanical description of granular materials. One of the tasks of rheology is to empirically establish the relations between the formations and stresses.

Rheology has important application in engineering, geophysics and physiology. In particular hermorhelogy, the study of blood flow, has enormous medical significance. In engineering rheology has had its dominant application in thedevelopment and use of polymeric materials.(http://wikipedia.org/wiki/rheology

2.1.2 Classification of polymer

All polymers can be divided into two major groups based on their thermal processing behavior. Thermoplastic are those polymers that can be heat softened in order to process them into a desired form. Waste thermoplastic can be recovered and fabricated by application of heat and pressure, polystyrene is an important example of a commercial thermoplastic. Other major examples are the polyolefin e.g. (polyethylene and polypropylene) and polyvinyl chloride.

Thermoset are polymers whose individual chains have been chemically linked by covalent bond during polymerization or by subsequent chemical or thermal treatments during fabrication. Once formed, this covalently cross linked thermally stable network resist heat softening, creep and solvent attack, but can be thermally processed. Such properties make the thermoset suitable materials for composites coating and adhesive applications, principal example of thermoset include epoxyl, phenol formal dehyde resins and unsaturated polyesters.

2.1.3 Polymer structure

The properties of polymers are strongly influenced by details of the chain structure. These details include the overall chemical composition and the sequence of monomer units in the case of co polymers, the stereochemistry or tactility of the chain.

Copolymers

Often it is to obtain polymers with new derivable properties by linking two or three different monomers or repeating units during polymerization. Polymers with two different repeating units in their chains are called copolymers. The exact sequence of monomer unit along the chain can vary widely depending upon the relative reactivity of each monomer during the polymer processing.this linkages are shown below.

Random

A-A-B-A-A-B-A-A-B-B-B-A-A-B-B-A

Alternating

A-B-A-B-A-B-A-B-A-B-A-B-A-B-A-B

ABA-triblock

A-A-A-A-B-B-B-B-B-B-B-B-A-A-A-A

Where A and B are monomers or repeating units during polymerization.

Tacticity

In addition to the type, number and sequential arrangement of monomers along the chain, the spiral arrangement of subsistent group is also important in determining the properties. of a polymer. The possible steric configuration of a symmetrical vinyl-polymer chain can be best represented by drawing the chain in its extended chain or plainer zigzag configuration (geometrical arrangement of atoms in the polymer chain). (Joel Fried,1979).

2.2 Polyethylene

Ethylene, one of most important petrochemicals may be polymerized by a variety of techniques to produce products as diverse as low molecular –weight waxes to highly crystalline, high molecular-weight polyethylene (HDPE). Polyethylene is one of the simplest polymers from the point of view of its chemical structure. Polyethylene is so diverse that it is difficult to make a systematic study of their physical properties. It is virtually impossible to find two samples that are identical from all points of view. Polyethylene or polyethene is a thermoplastic commodity heavily used in consumer products (over 60M tons are produced world- wide every year).Its name originates from the monomer ethane, Also known as ethylene used to create the polymer polyethylene. At room temperature, the structure of polyethylene is semi-crystalline. Polyethylene is used mainly for packaging .Polyethylene is one of the plastic which is least permeable to water vapor. Actually, numerous have been found for this product.

In polymer industry, the name is sometimes shortened to PE, similar to how other polymers like polypropylene and polystyrene are shortened to PP and PS respectively. The ethane molecule is connected by double bond, thus;(Joel Fried,1979).

```
H   H
|   |
C = C
|   |
H   H
```

Fig 2.2.1

Polyethylene is created through polymerization of ethane. It can be produced through radical polymerization, anionic polymerization, ion coordination polymerization or cationic polymerization. This is because ethane does not have any subsistent groups which influence the stability of the propagation head of the polymer. Each of these methods results in a different type of polyethylene.

In addition to copolymerization with alpha olefins, ethylene can also be copolymerized with wide range of other monomers. Common examples include vinyl acetate (resulting product is ethylene vinyl acetate copolymer, or EVA, widely used in athletic shoe sole), and a variety of acrylates (application include packing and spotting).

Depending on the crystallinity and molecular weight melting point and glass transition may or may not be observable. The temperature at which this occur varies strongly with the type of polyethylene. For common commercial grades of medium density and high density polyethylene, the melting point is typically in range 120°c-130°c. The melting point for average commercial low density polyethylene is typically 105°c-115°c. Most LDDPE and HDPE grades have excellent chemical resistance and do not dissolve at room temperature because of the crystallinity. Polyethylene (other than cross linked polyethylene) usually can be dissolved at elevated temperature in aromatic hydrocarbon (toluene, xylene) or chlorinated solvent (i.e. trichloroethane, and trichloobenzene).

Polyethylene is classified into several different categories based mostly on its density and branching. The mechanical property of PE depends significantly on variables such as the extent and type of branching, the crystal structure and the molecular weight (Mcgraw-hill, 1982).

Low density polyethylene (LDPE)

It is defined by density range of 0.919-0.940g/cm. LDPE has a high degree of short and long chain branching, which means that the chains do not pack into a crystalline structure as well. It has therefore, less strong intermolecular forces as instantaneous dipole; induced di-pole attraction is less. This results in a lower tensile strength and increased ductility. LDPE is created by free radical polymerization. The high degrees of branching with long chains give LDPE unique and desirable flow properties.(Joel Fried,1979).

LDPE is unreactive at room temperatures, except by strong oxidizing agents and some solvents. It can withstand temperature if 80°c continuously and 95°c for a short time. It is translucent or opaque, quite flexible and tough to the degree of been almost unbreakable. It is widely used for manufacturing various containers, dispensing bottles, wash bottles, tubing and various modern laboratory equipment. The most common household use of LDPE is in plastic bags.

High density polyethylene (HDPE)

It is defined by a density greater or equal to 0.941g/cm^3. HDPE has a low degree of branching and thus stronger intermolecular forces and tensile strength. HDPE can be produced by chromium/silica catalyst, zigler-natta catalyst or metallocene catalyst (chromium catalyst or zigler-natta catalyst and reaction conditions). The most common household use of HDPE is in containers for milk, liquid laundry detergents e.t.c. HDPE is also widely used in the fireworks community. Recently, much research activity has focused on the nature and distribution of long chain branches in polyethylene. In HDPE a relatively small number of this branches (perhaps one in hundred or one thousand branches per back bone carbon) can significantly affect the rheological properties of the polymer.(Joel Fried,1979)

2.2.1 Uses of polyethylene

Polyethylene has a huge variety of both domestic and industrial uses. Polyethylene has been found to be very useful due to its following properties and factors:

- Insulation properties
- Chemical resistance
- Strength
- Flexibility
- Non toxic nature
- Waterproof properties
- Unreactive nature
- Ability to be used in an extremely thin film
- Ease of production and fairly low production cost

Some of the uses of polyethylene in our world include:

- Molding plastic bottles
- Lids and caps
- Different types of containers
- Films glad wrap and various plastic bags
- Cable covering, various pipes and insulating wire cables.

2.3 Candles

Candles are a light source usually consisting of an internal wick which rises through the center of column of solid fuel. The major additive in the production of candle is stearin. Stearin is regarded as fat, that is, the triglyceride stearic acid, $CH_3(CH_2)_{16}CO_2H$, i.e. the tri stearate ester of glycerol. It is a white crystalline solid at ordinary temperature and is insoluble in water and very slightly soluble in alcohol. It is found in many hard fats and oils, e.g., tallow, butterfat, cottonseed oil and olive oil.

Stearin is sold in the form of powdery white crystals. It is usually added to melted paraffin wax to make the candle more opaque, it makes white candles and improve the brightness of colored candles and burning quality of candles. It essentially acts as a hardener for low melt point waxes and lowers the melt point of higher temperature waxes.

Wick is plaited, braided, impregnated with chemicals. It is manufactured in several sizes and the size f the wick chosen is dependent on the size of the mould. As a rule of thumb: candles of 2inches (50mm) diameter use small wick. Anything larger, use a large wick. For candles molded without a wick, e.g. stacked candles, use wax-stiffened wick.

Prior to the being ignited, the wick is saturated with the fuel in its solid form. The heat of the match or other flame being used to light the candles first melts and then vaporizes a small amount of fuel. Once vaporized, the fuel combines with oxygen in the atmosphere to form a flame. The flame then provides sufficient heat to keep the candle burning via a self sustaining chain of events: the heat of the flame melts the top of the mass of the solid fuel; the liquefied fuel is then vaporized to burn within the candle's flame.

The burning of the fuel takes place in several distinct regions (as evidenced by the various colors that can be seen within the candle's flame). Within the bluer, hotter regions, hydrogen is being separated from the fuels and burn to water vapor. The brighter, yellower part of the flame is the remaining carbon soot being oxidized to form carbon dioxide. As the mass of the solid fuel is melted and consumed, the candle grows shorter. Portions of the wick that are not evaporating the liquid fuel are ideally consumed in the flame, limiting the exposed length of wick and keeping the temperature and the rate of fuel consumption even.

Black soot deposition (BSD) can be concerned to those who frequently burn candles indoors and is also referred as ghosting, carbon tracking, carbon tracing, and dirty house syndrome. Soot can be produced when candles do not burn the wax fuel completely. Scented candles are the major source of candles soot deposition. Trimming candle wicks to one fourth of an inch is recommended to keep soot production at the minimum. A flickering flame will produce more soot therefore candles should be burned in an area free from drafts.

2.3.1 Candle history and development

Candles were developed independently in many countries. The Egyptians and Cretans made candles from various forms of natural fats, tallow and wax. In the 18th century, colza oil and grape seed oil came into use as a much cheaper substitute. Paraffin was distilled in 1830, and revolutionalized candle making, as it was and inexpensive material which produced high quality odorless candles that burns reasonably cleanly and was used during the colonial days. The industry was devastated soon after, however, by distillation of kerosene. This excellent fuel relegated candles to their current status as primarily decorative item (http://en.wikepedia.org/wiki/candle)

2.3.2 Uses of Candles

Prior to the domestication of electricity, candles were a common source of lighting, before and later in addition to the oil lamp. Due to local availability and the cost resources, for several centuries up to the 19^{th} century, candles were more common in northern Europe and olive oil was common in southern and Mediterranean sea. Makers of candles were known as chandlers.

Today, candles are usually used for their aesthetic value, particularly to set a soft, warm and romantic ambience, and emergency lighting during electrical power failures. Scented candles are common in aromatherapy. Small candles are often placed an birthday cakes, candles are also used in the religious ceremonies of any faith.

2.4 Wax

Wax usually refers to a substance that is solid at ambient temperature and that, on being subjected to slightly higher temperature, becomes a low viscosity liquid. The chemical composition of waxes is complex: all of the products have relatively wide molecular weight profile, with the functionality ranging from products, which contain mainly normal alkanes to those, which are mixtures of hydrocarbons and reactive functional species.

2.4.1 Classification of waxes

Paraffin wax

Paraffin wax is macro crystalline, brittle and is compound of 40-90 wt % normal alkanes, with the remainder c18-c36 isoalkanes and cycloalkanes. Paraffin wax has little affinity for oil content: fully refined paraffin has less than 1 wt% crude oil, 1-2 wt% and slack 64742-61-61, above 2 wt %. Within these classes, the melting point of the wax determines the actual grade, with a range of about 46-71°C.(http://www.gujurat waxes_com/about waxes.html)

Slack wax

A semi refined wax, distinguished from scale wax by having generally higher oil content. Semi-refined slack waxes may have oil content up to 30 mass percent. Slack waxes with oil content below 10 mass percent are used for manufacturing religious candle. Slack wax is the crude wax produced by chilling and solvent filter pressing was distillate. There are basically three types of slack wax produced, the type depending on the viscosity of the lube oil being dewaxed: low waxed, medium neutral and heavy neutral.

Scale wax

Soft semi-refined wax, distinguished from slack wax by having a generally lower oil content; usually derived from slack wax by extracting most of the oil from the wax. Waxes with oil content up to 3.0 mass percent are generally reefed to as scale waxes.

Microcrystalline wax

Microcrystalline waxes differ from refined paraffin wax in that the crystal structure is more branched and the carbon chains are longer. These waxes are tougher, more flexible and have higher tensile strength and melting points. They are also more adhesive, and they bind solvent oil, e.t.c, and thus prevent the sweating out of composition. Typical content by weight is between 0.5% and 2%.

Polyethylene wax

Polyethylene waxes are manufactured from low molecular weight, high density raw materials, designed to give the particular performance characteristic required by industry.

Petrolatum

Petrolatum is the wax byproduct of the heaviest lube oil, bright stock. Petrolatum wax consists of a natural mixture of microcrystalline wax and oil. It has good oil holding capacity that when filtered and blended it becomes mineral jelly. When fully refined it becomes microcrystalline wax.

White oil (Mineral oil)

White oil are colorless, odorless, tasteless mixture of paraffinic and naphthenic hydrocarbons that span a viscosity range of 50-370 SUS at 100°F. These nearly chemically inert oils are virtually free of nitrogen, sulphur, oxygen and aromatic hydrocarbons. They are common ingredient in pharmaceuticals, cosmetics, plastics, textiles and foods. .(http://www.gujurat waxes_com/about waxes.html)

Bayberry wax

Also known as myrtle wax of candle berry. Rare and expensive natural wax derived by boiling the berries of the bu

sh. The waxy coating of the berries boils off and floats to the top to be collected. This wax has a natural greenish color and a fresh natural scent. This wax as a general melts point of 116-120 and is hard and brittle. The wax (Myrtle wax) consists of glycerides of stearic, palm tic and myaristic acids, and a small quantity of oleic acid.

Beeswax

Beeswax is also available at several candle making supply companies and even some local beekeepers, but is much more expensive than paraffin. Beeswax has a melt point around 146 and makes a high quality candle. Pure beeswax burns longer and cleaner with minimum dripping and less smoke than candle made with other waxes. It is a light to golden yellow wax naturally produced by honey bees, and it has a slightly sweet honey-like scent. Often used in cosmetics and candles, as well as wood polishes, and various other applications. If you do not want to use straight beeswax, you can also add beeswax to your paraffin wax to save some money and still end up with a better candle.

Palm wax

A 100% natural wax derived from palm. It is a hard wax with a high melt point around 140, and is known to produce crystalline look. It usually comes in flake form. It can be used straight or as an additive to other natural and synthetic waxes.

Soybeans wax

Soy waxes are all natural waxes made from the soybean. They come in several mallet points for different applications. These are generally clean burning waxes that produce little soot. There are low to medium melt point blends from 120 to 125 for container candles and higher melt points for pillar and votives. Some soy wax are pure soy, and some are blended with other natural and botanical oils. These waxes are known to be non-toxic, biodegradable and environmentally safe, and longer burning than paraffin. Advantages are they can be safely melted in the microwave, the usually only require one pour, they clean up with just hot water and soap, and they work well with both fragrance oil and essential oils.

Recycled wax

You can use pieces of old leftover candles and recycle them. Just save all your old taper and pillar stubs and pieces of wax from old jar candles to remelt and make into new candles. Or you can break them into small pieces and fill a container, then over pour with clean paraffin to make recycled chunk candles.

2.4.2 Chemical composition and Properties of waxes

The most typical chemical constituent of natural waxes as a group are the esters of long –chain fatty alcohols and acids. Petroleum waxes and certain other mineral waxes, however consist of hydrocarbons. Aliphatic or open chain structures with relatively little branching or side chains can be considered typical for both ester and hydrocarbon waxes.it could be said that the functional element found in waxes are carbon, hydrogen and oxygen.

Other compound that could be found in waxes are hydrocarbon, alkyl, esters, primary alcohol, acids, ketones, aldehyde, secondary alcohols, hydeoxyl acids, lactones, acetols diols, dicarboxylic acids, di-ketones, polyester etc.(mcgrawHill,1982).

2.4.3 Wax Application and Uses

Below is short list of the most applications of waxes, since it is practically impossible to mention all various applications a wax can be used for.

Table 2.4 Wax Application and Uses

S/NO.	WAX APPLICATION	USES
1.	Adhesive and Glues	Regulates viscosity, flow and setting time
2.	Asphalt and Bitumen	Regulates density and augments longevity
3.	Candles	Base component, fuel for controlled combustion

4.	Wooden barrels and containers	The internal surface coating prevents the wood from being penetrated by its content
5.	Food wrappers	Prevents leakage, protects from dehydration
6.	Electric cables	Fills gaps between

CHAPTER THREE
Materials and Methodology

3.1 Apparatus and Materials

- Heat source (furnace)
- Melting can
- weighing balances
- Stirrer
- Mould
- Scissors
- Syringe
- Water-bath
- Polyethylene bags
- Stearic acid (stearin)
- Paraffin oil
- Thinner
- Cotton wool
- Wick

3.2 Experimental procedure

The procedure carried out in order to achieve the objectives are;

3.2.1 Pretreatment

The polyethylene bags were collected washed and dried to remove dirt and then sachets prints removed by gently scrubbing off using thinner and cotton wool.

3.2.2 Mould preparation and wicking

The inside of the mould was made clean, A length of wick chosen to suit the mould was cut at least 10cm longer than the length of the mould,the wick threaded through the hole made in the bottom of the mould and a secure d knot tied. A wick holder was placed across the top of the mould and the wick secured to it. It was ensured that the wick was centered in order for the candle to burn evenly. The mould was warmed to improve the candle finishing

3.2.3 Preparation of wax (polyethylene wax)

The polyethylene sachet were cut into smaller pieces, put into a pot and then subjected to heat. Cutting of the polyethylene into smaller pieces was done to increase the surface area and thus increase the rate of reaction (melting).

It was heated until it began to melt.

When completely molten then it was allowed to cool. About 20g and 5g of stearic acid measured with the aid of weighing balance and 30ml of paraffin oil measured with the aid of a syringe were added to the molten polyethylene.The molten polyethylene was gradually and gently poured into the moulds and the wick held at central position in order to ensure that the wick stays at the center. After which the moulds and the wax is transferred into water bath and then allowed to cool for about 5minutes.The candles which at this point are solid were gradually taken out from the mould. Seam lines were removed with the aid of a pair of scissors or razor blade.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION OF RESULTS

4.1 RESULTS

Table 4.1

	Stearic acid (g)	paraffin oil (ml)	Pure water sachets (bags)	Properties of product
Product 1	20	30	40	Hard and brittle
Product 2	5	30	20	hard

4.2- Discussion of Result

The melting of polyethylene and subsequent inclusion of additives such as stearin, paraffin oil, produced a polyethylene-based candle wax.

From the product obtained from the research,

In the course of the experiment it was found that gas evolved as the polyethylene bags were being melted. As a result, the mass of the polyethylene decreased after melting. The observed colour of the product was dark green.

Paraffin oil as an additive to the polyethylene wax, tends to improve the flow and pour properties of the polyethylene wax. Also, variation of its amount could be seen as the major factor determining the rate at which the polyethylene candle burns. According to the results, comparison made between the polyethylene candles produced shows that the higher the concentration of paraffin oil added, the faster the burning rate.

Also, the relationship of the wick to the wax type and container or mould size is important for getting a long burning candle. Comparatively, a fatter wick is used for larger candles or for candles made from long burning wax, like beeswax or paraffin incorporated with hardening additives.

The molten wax should be free from any form of impurity (such as the sachet prints) in order not to interfere with the wick capillarity or quality of the candle being produced.

CHAPTER FIVE

5.0 – Conclusion and Recommendation

5.1 –Conclusion

From the research carried out and the result obtained ,it has shown that polyethylene which is an inexpensive and readily available type of polymer can be an absolute substitute for the popularly and widely used feed stock for candle production If this abundant resources found in our environment is properly harnessed and put to use(in the production of candle).It will not only serve as a source of employment but it will go along way to keeping our environment free from waste generated by polyethylene and polyethylene related product due to it non-biodegradable nature.

5.2 Recommendation

Since polyethylene related products are produced in greater volume than any other plastic and constitute most plastic waste,More attention should be channeled into making sure that polyethylene and its associated wastes are properly collected with the view to effectively transforming or recycling it into useful product such as candle.

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