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Achieving Vision 20:2020 Through Waste Produce Candle

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Abstract: Polyethylene products although are widely used all over the world, the environmental problems caused by their disposal are enormous hence, it is necessary to explore alternative means of recycling them into further useful products. In this research, used-water sachet polyethylene, which is non-biodegradable, was recycled to candle, a biodegradable product. Using four different formulations, by employing simplistic unifactor approach, 4 different candle samples were produced. The formulations entailed the addition of 0, 10, 20 and 30 g of stearic acid to the active ingredient. In order to determine their mass, weight and burning efficiency for 15 min, the samples were analyzed in our laboratory so as to using standard methods. It was observed that 6.5, 4.7, 3.3 and 2.1 g of wax were consumed with a respective reduction in candle height of 6.1, 3.8, 2.0 and 1.2 cm within 15. It was also observed that as the amount of stearic acid increased, the candles produced were harder, burns for a longer time, gave a brighter burning flame with a little or no smoke/soot. In conclusion, used-water sachet polyethylene, which constitute environmental problems were converted to candle, a use full product.

Key words: Used-water sachet polyethylene, recycling, candle, stearic acid

INRODUCTION

Wastes are inevitable and can be found everywhere. They are the essentials and ubiquitous derivatives of every process. Waste therefore can be defined as any garbage, rubbish or other discharged materials resulting from industrial, commercial, domestic, mining and agricultural activities. In a sense, waste can be regarded as any material discarded as having no consumer value to the person abandoning it. Wastes pollute the environment if they are not properly disposed and managed. On the other hand, if properly disposed and managed will not constitute any environmental problem and as such, pollution will eradicated. This is because wastes are just (useful) materials in the wrong place. (Ahmadu, 2007). Thus waste can simply be considered as nothing but unsorted scraps. Scraps are useful raw materials that can be recycled into new products. Thus, the enormous problems caused by used and wrongly disposed polyethylene products (used water sachet) can be reduced to barest minimum if properly sorted and recycled into useful products typical of candle.

Polyethylene products are used all over the world for more than one million applications. Such applications/products are abound which includes various bags, plastic bottles, cling wraps, insulation cables, bowls, caps, baskets, lids just to mention a few. They are so widely used that for some people life would be almost impossible without polyethylene. As widely as the polyethylene products are used, so also are their spent/used parts/components are littered all over the places constituting serious environmental mishap and other related problems. To compound the issue, these used-polyethylene products are non-biodegradable thereby making if absolutely impossible to be consumed by micro-organisms of disposal. Used-water sachet polyethylenes are the most widely used polyethylene in Nigeria. Pure water making factories both licensed and unlicensed are found in virtually every street in cities, towns and villages of Nigeria. During the dry season, about 70% Nigerian adults drink at least one sachet of pure water a day. This means that about 50-60 million used water sachet are thrown into the streets of Nigeria on daily basis. This is evident as all over the street corners of virtually every city, towns and villages in Nigeria are littered with various used-polyethylene products as wastes. This large volume of used-water sachet polyethylene constitutes unprecedented environmental hazard which span from littering the street to blockage of drainages/channels. In view of the above highlighted environmental problems, this research is therefore, yet another waste management approach to

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solving some of the problems arising from used-water sachet polyethylene disposal. The research in particular targets the recycling of used-water sachet polyethylene, a non-biodegradable waste, into candle, a biodegradable product. This is because, candle burns off with nothing left as waste.

Some properties of polyethylenes: Polyethylene is probably the polymer we see most in our daily life. It is the most popular plastic in the world. It has a very simple structure, the simplest of all commercial polymers. It is composed of chains of repeated-CH_2-units. It is produced by addition polymerization of ethylene $CH_2 = CH_2$. The properties of polyethylene depend on the manner in which ethylene is polymerized. When catalyzed by organometallic compound at moderate pressure (15-30 atm), the product is high density polyethylene (HDPE). Under these conditions, the polymer chains grow to a very great length and molecular weight average many hundred thousands. HDPE is hard, tough and resilient. Most HDPE are used in the manufacture of containers such as milk bottles and laundry detergent bags. When ethylene is polymerized at high pressure (1000-2000 atm) and elevated temperature (190-210°C) as well as catalyzed by peroxides the resulting product is low density polyethylene (LDPE). This form of polyethylene has molecular weight ranging from 20,000-40,000 g. LDPE is relatively soft and most of them are used in the production of plastic films such as those used in sandwich bags. These polymeric materials are generally thermoplastic as such are heat convertible and can be recycled from one product to the other type of used-water sachet polyethylene.

Used-water sachet polyethylene can be recycled into useful products. However, many of these recycled products e.g., grocery bags, shampoo bottles, toys, footwear, etc are still non-biodegradable. This will still lead to another environmental disposal (pollution and littering) problems. This is why candle, a biodegradable material was chosen as the end product of this research. It is not harmful and cannot pose any environmental problem since it burns off without smoke during use (Fergusson and Michael, 1974).

Polyethylene and candle production: Candles are the ancient and traditional sources of household lighting. However, in a developing economy like Nigeria where power outages and shortages are rampant, the use of candle is still one of the most popular household lighting means. The demand for candle for varied purposes aside from its traditional usage is on increase. Candle is now made in various shape and sizes, including the now popular and scintillating aroma candles. Candle making has become a thriving industry and one can observe the mushrooming of candle shop selling ready-to-make candles, moulds, wax, wicks, essential oil and other requirement of the enterprise. At present there are different type of candles such as decorative, gel, spring and classical or aroma candles.

The basic raw material needed in candle making is the wax. Waxes are thermoplastic materials that soften when heated and return to their original condition when cooled), but because they are not high polymers, that is macromolecules consisting of large number of monomers, they are not considered as plastics. Most waxes are combustible, water repellant, smooth texture, non toxicities and are free of objectionable odors. Waxes usually refer to a substance that is solid at ambient temperature and that on being subjected to slightly higher temperature becomes a low viscous liquid. Chemically, a wax is a type of lipid that may contain a wide variety of long-chain alkanes, esters, polyesters and hydroxy esters of long-chain (primary alcohols and fatty acids). They are usually distinguished from fats by the lack of triglyceride esters of glycerin (propan-1,2,3-triol) and three fatty acids. Thus, the chemical compositions of waxes are complex. Waxes are of various types depending on their sources and applications. These include petolum wax, insect and animal wax, vegetable wax and synthetic wax. These waxes are easily formulated into candles by properly incorporating in the right proportion of stearic acid, wig and dye. The candles made of stearic acid are characterized by a distinguished burning behavior that has a light, quiet flame and a pleasant smell. It gives a well functioning burning pool when in use.

Wick is made from cotton strands. It has the duty of absorbing the fuel in the burning zone. Its structure is dependent on the type, the diameter and the production method of the candle. Preferably the wick is braided from cotton fibers. The wick is prepared to ensure that the fuel will not extinguish the flame and to provide for an even burn with a tranquil flame. The braiding also exerts a crucial influence on the optimal burning and lighting of the wick. The top of the wick has to bend to the outmost rim, where the oxygen flows into the reaction zone. This will give a complete burning. If the tip of the wick stays in the flame then it burns imperfectly and a soot mushroom is created. If the wick is too weak, then it cannot absorb the melted wax in the burning pool. This will cause the burning pool to overflow and the candle to drip. If the wick is too strong, it will absorb all the melted wax and thus makes the burning pool constantly empty. This will give an imperfect burning since, the flame will be big and smoky and the candle burns faster. The most common type of wicks used with candle wax is cotton, zinc core and coated wicks.

More colors and shades are always created and are essential for a good candle. The dyes for dipping and for the complete dying are technically distinguished from one another. Dyes that are used mainly for dipping are based from original pigments. Normally only the outer candles are coated while the cores remain white/plane. The advantage of pigment base built dyes is that it is non-fading and does not bleeding the packaging. Dyes for candle making are available in liquid, powder and chip form.

In Nigeria, over 90% of the raw materials required for candle production are imported and has forced all the 44 registered producers of domestic candles out of business (RMRDC and MAN, 2001).

Table 1 gives the raw material situation for candle production in Nigeria.

The goal of vision 20: 2020 is for Nigeria to be one of the 20 largest economy in the world by year 2020. This vision and the debate surrounding it, continues to expose the limitations of Nigerian economy. The economy is largely dependent on the oil sector and the non diversification of other viable sectors makes the economic growth required to meet the vision 2020 an illusion. Thus, there is a need for the 2020 vision to direct its policy searchlights onto the private sector and serious attention firmly focused on the manufacturing and service sectors. Championing the regional excellence in these two sectors will alone move the economy in leaps and bounds (Atser Godwin, 2008).

Why service sector?. This is because it accounts for about 30% of Nigeria's National Product and provides employments for about 60% of the working population. It is impossible to drive an economy so constituted, ignoring 60-70% of the working population. With or without this 2020 vision, the working population in turn looks after a multiplier effect of relatives whose revenue act as disposable incomes that are expected to drive the economy (Nigerian Federal Executive Council, 2008). It then becomes imperative that sourcing the raw materials for candle making locally will no doubt reduce production cost and consequently making candles available and at relatively cheaper prices.

Table 1: Raw material situation for candle making in Nigeria

Raw material	Source	Status (%)	Comment
Parafin wax	Imported	100	Production ceased at the Kaduna Refinery and Petrochemical company Ltd.
Stearic acid	Imported	100	Potential for local sourcing exists in NARICT*
Oil soluble dye stuff	Imported	100	Potential for local sourcing exists in NARICT*
Packaging materials	Local	100	
Wick	Local	100	

*NARICT = National Research Institute for Chemical Technology

MATERIALS AND METHODS

Experimental procedure; pretreatment of used-water sachet polyethylene: The used-water sachets were gathered from various locations in Minna Metropolis and were subsequently screened and washed using detergent to remove unwanted materials. The use-water sachet polyethylene was bleached with nitrocellulose thinner so as to remove paints on the surface of used-water sachet polyethylene. This was followed by drying the used-water sachet polyethylene.

Moulds and wick reparation: Four moulds were prepared using paw-paw leave stems of about 2 cm diameter. They were cut to the same length of 20 cm each. One end of the moulds was covered with a small piece of footwear cut to size (diameter) of the paw-paw leave stem with an opening for inserting the wicks at the center. The wicks were held firmly at both ends of the moulds with the help of a pencil like sticks. The moulds were implanted inside the sand (ground) to hold them in an up right position and to enhance rapid cooling of the molten wax.

Polyethylene wax preparation: The cleaned and dried used water sachets were placed inside a steel container and the container placed inside a furnace. The container and its content were heated until a clear liquid state was achieved. This was followed by light heating while the

Table 2: Materials used for the experiment

Materials used	Models	Comments
Thermometer	DURAN, Germany	Measures temperatuire
Weighing balance or scale	METTLER pm 2000 made in England	For weighing
Steel spoon		For Stirring
Scissor		For Cutting
Steel containers		For heating wax in the Furnance
Stearic acid		To harden the wax
Wick	Coated	
Moulds	Local	Paw paw leave truck
Mould sealer	Froot wear	Used to seal on end of the mould so the molten wax will not leak out

Table 3: Formulation of candle

Samples	Polyethylene (%)	Stearic (%)
1	100	0
2	90	10
3	80	20
4	70	30

molten wax was carefully being sieved/filtered to remove impurities using a mesh. Filtered molten wax and the stearic acid were mixed in the ration as shown in Table 3. These were properly mixed and poured into the improvised moulds.

The moulds were slightly tapped by the sides so as to remove any trapped air bubbles during pouring. Upon solidification, the molten wax cooled and more molten wax was poured to ensure that the moulds were properly filled.

Physical analyses of the candles: Once the wax has solidified, the finished candles were removed by cutting the moulds open. The excess wax was trimmed and the candle properly dressed.

The 4 samples (samples 1-4) produced were weighed and their lengths measured. Subsequently the candles were lighted and allowed to burn for 15 min and the samples were reweighed and their length measured again.

RESULTS AND DISCUSSION

Table 4 gives the formulation of waxes into candles. It can be seen from the Table 4 that as the quantity of stearic acid increased the better the burning efficiency as well as a drastic reduction in the loss of wax. Generally, thermoplastic materials become soft when heated, flow when subjected to pressure and become rigid or solid when cooled to room temperature. In the same way, the used-water sachet polyethylene responded to heat treatment at a temperature of 350°C since it is also a thermoplastic. It yielded a molten wax with light green color. The high temperature of 350°C was necessary to ensure that the molten wax does not solidify and/or stick to the side of the moulds during the addition of stearic acid and subsequent pouring of the wax into the moulds. Stearic acid was used as an additive to harden the wax. This determines how long a candle burns. Hard candles are more likely to retain their shape when burning. The candles produced with stearic acid were found to drip less, sag less and burn longer. These effects were observed to increase as the ratio of stearic acid to wax increased. Also, increased amount of stearic acid produced a brighter burning candle. Candles without stearic acid produced doll flame, snowflake effect and melt fast.

The wax served as fuel while the wick was the absorbant. The wick absorbed the liquid wax and moved it upward while the candle burns. The wick was also treated with ammonium nitrate so as to prevent it from it burning too fast and the flame being extinguished by the molten wax which was also reflected in the burning rate of the treated and the untreated wicks.

From Table 3, it can be deduced that about 6.5 g of wax was consumed when the candle produced without stearic acid was burned for 15 min. However, with the addition of 10, 20 and 30%of stearic acid, the quantity of wax consumed was 4.7, 3.3 and 2.1 g, respectively depicting a significant reduction in the loss of wax during burning.

Table 4: The samples produced and the effecst of burning them for 15 min

			Before burning	
Material	Wax content (%)	Stearic acid (%)	Height (cm)	Weight (g)
Sample 1	100	0	11	10.7
Sample 2	90	10	11	11.0
Sample 3	80	20	10.9	12.3
Sample 4	70	30	11	14.2
Commercial Minna Mkt			11	14.4

	After burning		
Material	Height (cm)	Weight (g)	Wax loss
Sample 1	4.9	4.2	6.5
Sample 2	7.2	6.3	4.7
Sample 3	8.9	9.0	3.3
Sample 4	9.8	12.1	2.1
Commercial Minna Mkt	9.3	12.0	2.3

CONCLUSION

Used-water sachet polyethylenes which are found littered in every street corners in Nigeria can be collected and recycled into new raw materials which can be used to manufacture other useful products. In this study, used water sachet polyethylene was recycled and used to produce candle.

The environmental problems such as blockage of drainage channels, pollution and littering, caused by used-water sachet polythene can be reduced to the barest minimum.

Thus, if wax can be obtained locally by recycling used-water sachet polyethylene a huge sum of money will be saved. This will translate to having candle at relatively cheaper price.

Recycling of used water sachet polythene for candle making will provide job opportunity and income earning.

The addition of stearic acid has a great effect on the candle produced whose reflection showed that increase in the percentage of stearic acid, reduced the effect of soot and smoke as well as prolonged the burning time gave a better glossy flame. Above all, it can be concluded that candles with improved burning efficiency can be produced at Federal University of Technology, Minna, Nigeria, by recycling used-water sachet polyethylene.

RECOMMENDATIONS

This research was based only on the used-water sachet polyethylene. Further research on recycling all the used-polythene materials is recommended. This will increase the amount of wax to be generated. Further more, a more detailed formulation approach is recommended typical of statistical design based on n^k-factorial which will ensure optimum candle composition and hence improved burning efficiency.

The formulation of polyethylene wax with other wax like paraffin wax, bees wax etc should be studied to find out ultimate appropriate formulation for candle production.

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