International Journal of Chemical Engineering and Applications, Vol. 1, No. 1, June 2010
ISSN: 2010-0221

Laboratory Conversion Of Used Water Sachet (Polyethylene) To Superwax/ Gloss Like Material

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Abstract—**Polythene is the most common thermoplastic with wide range of applications (Tham, 2005) and numerous articles have been published about its processes and products. Nigeria in particular enjoys the use of polymer to the extent of embracing the concept of polymer made currency, unfortunately the good management culture of the used polythene is lacking. This research work however focuses on used water sachet- a grade of polymer, its effective management and potentials of conversion to a more useful product such as super wax. The formulation entails the combination of 10g, 15g of polythene wax to 60cm3 of K25 each and 20g, 25g of polythene wax to 100cm3 of K25 each. Four different samples which demonstrated good properties were produced. Averagely, a solidification time of 20-30 minutes was observed for each of the samples.**

Index Terms—**Polythene, Thermoplastic, Used water sachet, Gloss, K_{25}**

I. Introduction

Drinking water in the distribution system is not sterile, regardless of the degree to which the water is treated. The water contains microbes that survive the treatment process or enter the distribution system through the pipe network (Owolabi *et al*.,2010) Many of these microbes can attach to the pipe wall and become part of a biofilm. (US environmental protection agency, 2002).Several definitions for biofilms have been published in the literature (LeChevallier, 1999a; Berger *et al*., 1993; Characklis and Marshall, 1990; Characklis, 1981). There is not one universally recognized definition for biofilms; however, common among the definitions is that a water distribution system biofilm is a complex mixture of microbes, organic and inorganic material accumulated amidst a microbial produced organic polymer matrix attached to the inner surface of the distribution system. The inner surface of a water pipe may have a continuous biofilm, but usually biofilms are quite patchy (Walch, 1992; van der Wende and Characklis, 1990).Yet reliable supply of clean wholesome water is highly essential in a bid to promoting healthy living amongst the inhabitants of any defined geological region (Mustapha and Adam, 1991). The standard industrialized world model for delivery of safe drinking water and sanitation technology is, however, not affordable in much of the developing world Nigeria for instance (Gadgil and Derby, 2003). A local intervention in Nigeria, where public drinking water supply is unreliable (Egwari and Aboaba, 2002), is drinking water sold in polythene sachets.

Water sachet is found on the entire streets, nooks and crannies of various communities in Nigeria. Polyethylene products are used all over the world for more than one million applications. Such applications/products are abound which includes various bags, 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 polyethylene products are used, so also are their spent/used parts/components are found all over the places constituting serious environmental mishap and other related problems. To compound the issue, these used polyethylenes are non biodegradable. They therefore pose serious environmental problems to inhabitants especially where solid wastes are deposited in towns (urban areas) and villages (rural areas). Urban waste disposal is the responsibility of various municipalities, local government and/or city co-operations (Ramasastry, 1988).Where they function however, they are grossly inadequate despite today's technological know-how and renewed efforts towards effective waste disposal (Aziegbe,in press)

Fig. 1 dumpsite of polythene/water sachet, lagos, nigeria,

A lot of studies abound that focus attention on solid waste generation and disposal in Nigeria cities. Examples include Adedibo (1983) study of Ilorin and Offa, Kwara State; and Oyinlade (1991) study of Akure, Ondo State. Studies of waste generation and disposal with a focus on the Nigeria landscape include Onokerhoraye (1984); Omuta (1988);

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Dede (2000) and Fodeke (2002). In Edo State, and with particular attention to Benin City, it will include the study of Akpovi (1981), Ukut (2001) and Ramasastry (1988). A central theme that runs through these studies cited is that they examined generally, solid waste generation and disposal systems.

None has yet, focused on the generation and disposal of polyethylene with particular emphasis on water sachet and its conversion into usable materials. This knowledge gap specifically represents the focus of this study.

Waste is either a blessing or a curse; it all depends on how it is managed. When mismanaged in such a way that wastes are littered around for pathogenic organism to find abode for wide spread of diseases, waste is then a curse but when managed properly, recycled and converted to further usable materials in such a way that the Nigerian environments look cleaner and employment for both skilled and unskilled labour is generated, then it is a blessing. This paper however attempts to focus attention on used water sachet in Nigeria as a blessing.

Properties of Polyethylene

Polyethylene is an addition polymer that is created by the polymerization of ethylene monomer units. Ethylene can be polymerized by a radical mechanism under very high pressures and temperatures with the addition of an organic peroxide radical initiator. This reaction is thought to proceed as follows

$$\textit{Initiation}: \quad \xrightarrow{I \quad K_d} \quad 2R_1^{\bullet}$$

$$\textit{Initiation:} \quad \xrightarrow{H_2C{=}H_2C \quad K_g} \quad 2R_1^{\bullet}$$

$$\textit{Propagation:} \quad \xrightarrow{M : + Rj\bullet \quad K_p} \quad R_{j+1}^{\bullet}$$

$$\textit{Termination:} \quad \xrightarrow{Ri\bullet \ + Rj\bullet \quad K_t} \quad P_{j+1}$$

Polyethylene is created through polymerization of ethene. It can be produced through free radical polymerization, anionic addition polymerization, ion co-ordination polymerization or cationic addition polymerization. This is because ethene does not have any substituent groups which influence the stability of the propagation head of the polymer. Each of these methods results in a different type of polyethylene. The process requires a highly purified ethylene feed and the operating pressure ranges from 1000 to 3000 atm and a temperature range of 120-300^{0}C.Temperatures exceeding 300^{0}C cause ethylene to decompose and are not recommended in practice (Dhib *et al*., 2002).Therefore, the development of mathematical models to predict the process behaviour is important to ensure a stable operation, associated with an improvement in the properties of the produced polymer (Secchi., *et al*, 2005). For initiation, usually peroxides are used. Here, a mixture of different initiators is used; each of them decomposes into radicals depending on the temperature. In the presence of radicals, monomer starts to react with them, forming longer and longer radicals, so-called ″living polymer". The third main step in the free radical polymerization process is the termination step which ends the reaction.

TABLE 1:RAW MATERIAL SITUATION FOR SUPER WAX MAKING IN NIGERIA.

RAW MATERIALS	SOURCE	STATUS	COMMENTS
PARAFFIN WAX	IMPORTED	100%	PRODUCTION CEASED AT THE VARIOUS NIGERIAN REFINERIES AND PETROCHEMICAL COMPANIES. POTENTIAL FOR LOCAL SOURCE EXIST.
MICRO WAX	IMPORTED	100%	SAME AS ABOVE
WAX KP	IMPORTED	100%	SAME AS ABOVE
WAX O	IMPORTED	100%	SAME AS ABOVE
WAX E	IMPORTED	100%	SAME AS ABOVE
KEROSENE(K_{25})	*IMPORTED*	100%	SAME AS ABOVE

II. MATERIALS AND METHODS:

A. Treatment of used water sachet

The used water sachets were gathered from various locations within the Osobgo metropolis (longitude 4.5667 and latitude7.7667) of Nigeria. The sachets were screened, washed with detergents and dried. The dried sachets were soaked in nitrocellulose thinner to remove the labels and other ink related matter on the used sachets and later re-dried.

B. Used sachet water (polyethylene) wax preparation

The cleaned and dried water sachets were placed inside a steel container and the container placed inside a furnace. The container and its contents were heated until a clear liquid state was achieved. This was followed by light heating while the molten wax was sieved/filtered to remove impurities using a mesh.

C. Super wax preparation

The unit operations involved in the entire production are

1) Heating Cooling
2) Mixing. Solidification.

For each preparation, a specific amount of wax was weighed and gently dissolved in a known amount of heated kerosene (a petroleum fraction) using a can placed on a heating mantle. It took about 30-40 minutes for complete dissolution with aid of continuous agitation**.**

D. Uses of Super Wax

Super waxes are used in Nigeria in the manufacture of candles for religious and decorative purposes, and in polishes, matches, waxed paper, and cosmetics. Waxes are also generally used in the manufacture of rust preventives, rubber antioxidants, electrical insulators, paper coatings, printing inks, textile finishes, leather dressings. This range of products requires waxes of different melting points, as well as of different gloss, hardness, tensile strength, and ductility.

TABLE 2: MATERIALS USED FOR THE EXPERIMENT

Materials Used	Comments
Thermometer	Measures Temperature
Weighing Balance	For weighing
Steel Spoon	For stiring
Scissors	For cutting
Steel Container	For heating wax in the furnace
Heating Mantle	For heating

TABLE 3: FORMULATION USED FOR THE PRODUCTION

SAMPLES	POLYTHENE WAX CONTENTS(G)	K_{25} CONTENTS (CM^3)	SOLIDIFICATION TIME MINUTES
A	*10*	60	20-30
B	15	60	20-30
C	20	100	30-35
D	25	100	30-35

III. RESULTS AND DISCUSSIONS

Generally, low density polyethylene becomes softer when subjected to heat, flows when subjected to pressure and solidifies when cooled to room temperature. These exactly were the roles of the used water sachet in the super wax production. The k_{25} serves as the vehicle or solvent which dissolves the polythene wax.

All super wax produced using the formulation stated above demonstrated good properties.

IV. CONCLUSION AND RECOMMENDATION

Used water sachets have become uncontrollable nuisance in Nigeria. Most places are littered with the polymer made materials which are continuously dumped indiscriminately. In fact a considerable portion of the Nigeria land mass has been occupied by varieties of waste (FIG. 1). This research work tends to look at the used water sachets as blessing by converting them to a more useful product. The effective management of the polythene waste through conversion into further usable products turns the littered surrounding to an environmentally friendly one by preventing outspread of disease and simultaneously creating employment for both skilled and unskilled labour.Conclusively, used water sachet can be converted to super wax at the industrial chemistry department of Fountain University, Osogbo, Osun state, Nigeria. This is certainly a technology for reducing a growing waste problem by converting the waste to an environmental beneficial and valuable product.

The conversion of low density polyethylene i.e. LDPE (used water sachet) was demonstrated in this research. Efforts should be made in converting other polyethylene such as ;Ultra high molecular weight polyethylene (UHMWP),Ultra low molecular weight polyethylene (ULMWPE or PE-WAX),High molecular weight polyethylene (HMWPE),High density polyethylene(HDPE),High density cross- linked polyethylene (HDXLPE),Cross- linked polyethylene (PEX or XLPE),Medium density polyethylene (MDPE),Linear low density polyethylene (LLDPE), and ,Very low density polyethylene (VLDPE) to polyethylene wax for further conversion into further usable products.

Further work is highly recommended on the formulation used so as to have the most optimum process formulation.

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